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N. 13. J. Garwood

# MEMOIRS OF THE GEOLOGICAL SURVEY.

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## SPECIAL REPORTS ON THE MINERAL ^ RESOURCES OF GREAT BRITAIN.

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ENGI STORAGE

VOL. XXVII.—COPPER ORES

OF

CORNWALL AND DEVON

BY

HENRY DEWEY.

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PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.

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## PREFACE.

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The history of mining for copper-ore in Cornwall and Devon goes back no doubt to a remote period, but the time of greatest activity was about the middle of last century, when this district took a prominent place among the copper-producing districts of the world. Since then the decline has been continuous and in recent years the output has dwindled to a very small figure. There is reason to believe that many of the famous old mines are practically exhausted, and copper-ores have tended to become by-products of mining for tin and tungsten ores.

Much has been written about these mines, though the information is often not of a very detailed or scientific character, and in this volume the principal facts concerning them have been brought together, with statistics of output where these can be obtained. Only the more important mines or groups of mines have received special attention, but as the number of mines which produced only small supplies or were worked for a short period only is very great, and the information about them often scanty, no attempt has been made to describe every mine which has yielded copper in Cornwall and Devon.

In order to bring the information up to date Mr. Dewey has visited every active mine and many of those recently abandoned or of historic importance. Our thanks are due to the present mine managers for their courtesy and assistance. Full use has been made of the published accounts of mining in Cornwall and Devon, and reference to the principal sources of information will be found in the text and footnotes. Some of the plans and sections of mines have already appeared in Geological Survey Memoirs; the statistics have been brought up to date as far as possible. A list of the plans of abandoned mines deposited in the Mines Department is given in an Appendix.

Copies of the six-inch geological maps, published and unpublished, may be consulted in the library of the Geological Survey, London.

JOHN S. FLETT,  
*Director.*

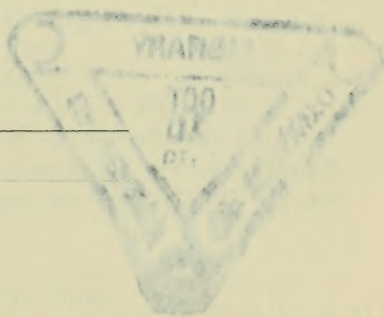
Geological Survey Office,  
28, Jermyn Street,  
London, S.W.1.  
4th January, 1923.



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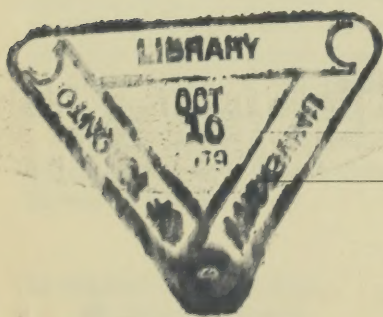
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# COPPER ORES OF CORNWALL AND DEVON

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## CHAPTER I.

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### INTRODUCTION.

#### MINERALS THAT CONTAIN COPPER.

Copper occurs in nature in the 'native,' or metallic state, and also in the form of sulphides, oxides, carbonates and other compounds. The names and composition of the principal ores of copper, and the percentage of metal contained in them, are given in the following table :—

Metallic copper

Chalcocite, redruthite, copper glance

or vitreous copper-ore

$\text{Cu}_2\text{S}$ . 79·8 % Cu.

Covellite or indigo copper-ore

$\text{CuS}$ . 66·5 % „

Erubescite, bornite or horseflesh ore

$\text{Cu}_3\text{FeS}_3$  55·58 % „

Chalcopyrite, copper pyrites, or  
yellow copper-ore

$\text{CuFeS}_2$ . 34·5 % „

Cupriferous pyrites

$\text{FeS}_2$ , carrying small quantities of copper.

Azurite, chessylite or blue carbonate  
of copper

$(\text{CuCO}_3)_2 \text{Cu}(\text{OH}_2)$ .

Malachite or green carbonate of  
copper

$\text{CuCO}_3, \text{CuOH}_2$ . 62 % Cu.

Melaconite or black oxide of copper

$\text{CuO}$ . 79·85 % „

Cuprite or red

$\text{Cu}_2\text{O}$ . 88·8 % „

Chrysocolla

$\text{CuSiO}_3 + 2\text{H}_2\text{O}$ . 36 % „

Enargite

$3\text{Cu}_2\text{S}, 2\text{As}_2\text{S}_3$ . 48·3 % „

Formerly many of these minerals were raised in Cornwall and Devon, but in recent years the principal ore won with the tin-ore has been chalcopyrite.

#### DISTRIBUTION OF THE ORES.

During the early part of the 19th century more than half of the world's output of copper-ores was contributed by Cornwall and Devon, but the richest copper zone was passed through as the mines were deepened, and the output steadily declined. In 1840 rich deposits of copper-ores were discovered in South America and afterwards in Mexico and the United States, but the amount of copper-ore raised in Cornwall and Devon increased until 1860



and then fell rapidly. The proportion of copper-ore contributed to-day by England and Wales to the world's output is insignificant. Plate I, and the tables on pp. 9-11 show the steady decrease since 1860, and as the mines are working each year at deeper levels the output is not likely to be increased.

In Cornwall and Devon there are several mining-districts where copper-ores are being raised in small quantities, and some others where there are no active mines; but the assemblage of minerals is not everywhere the same. Formerly rich grey ore was mined in St. Just, Breage and St. Austell; red and black oxides and blue and green carbonates in the Caradon district; great cindery courses with rich gossans in Gwennap; and siliceous ore in Tavistock; but, as described on p. 4, all of these ores were probably derived originally from chalcopyrite.

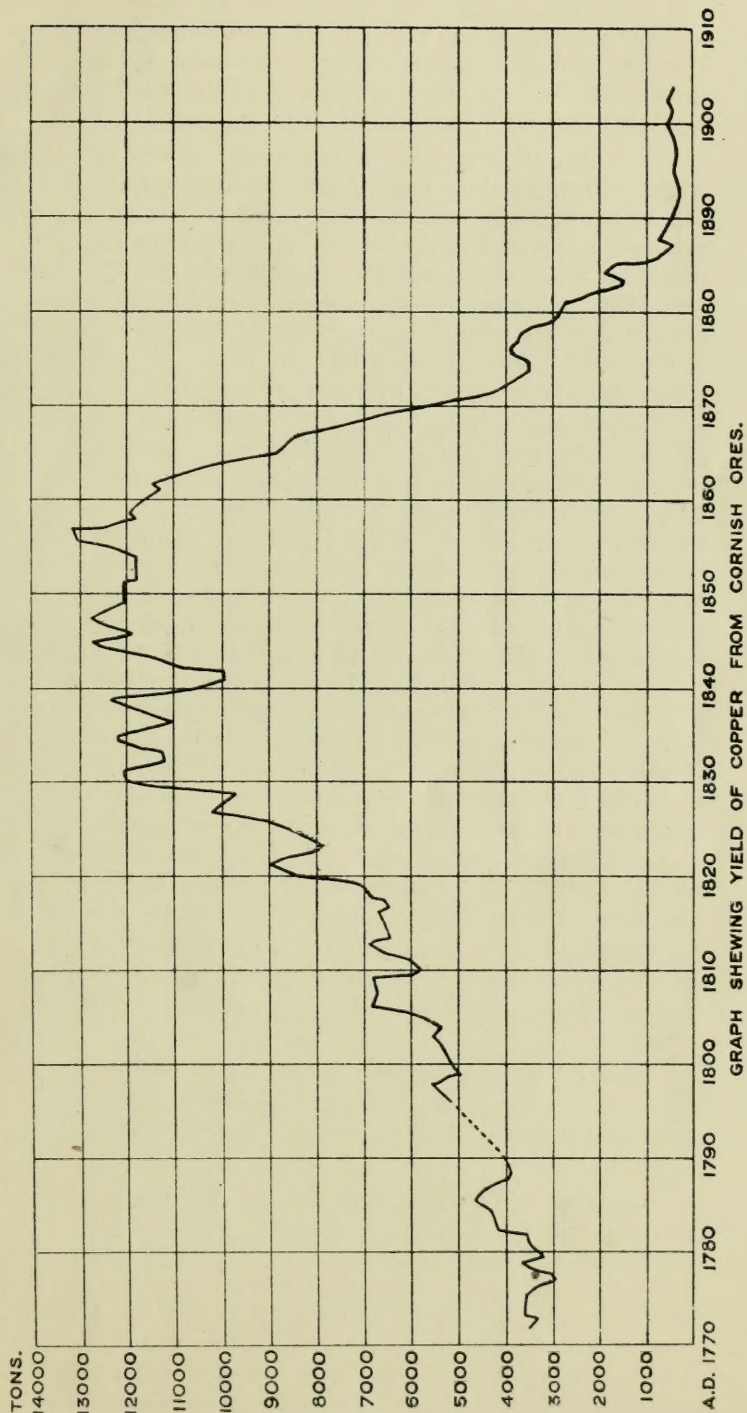
Copper-ores, despite their wide distribution, are not found in all the Cornish mines, and, although they occur habitually in or near the granite masses, do not occur over the whole of those areas. There are several productive areas, each near a granite mass, which are indicated on Plate II by the numerals I to V. The most westerly of these lies in the parish of St. Just in Penwith and adjacent to the western margin of the Land's End granite, where Levant is the most important mine, while another group, in the parish of St. Ives, is found a few miles to the north. The second district includes all the principal active mines and most of those that have produced the largest quantities of ores in the past. They are situated around the Carn Brea granite and include South Crofty, East Pool, Tresavean, Dolcoath, Tinicroft and Grenville. In the adjoining parish of Gwennap the Great Consolidated Group was formerly the chief producer of copper-ores and, although all the mines are idle, the district cannot be regarded as exhausted. The same remark applies to the mines in the parish of Crowan and on the Binner Downs.

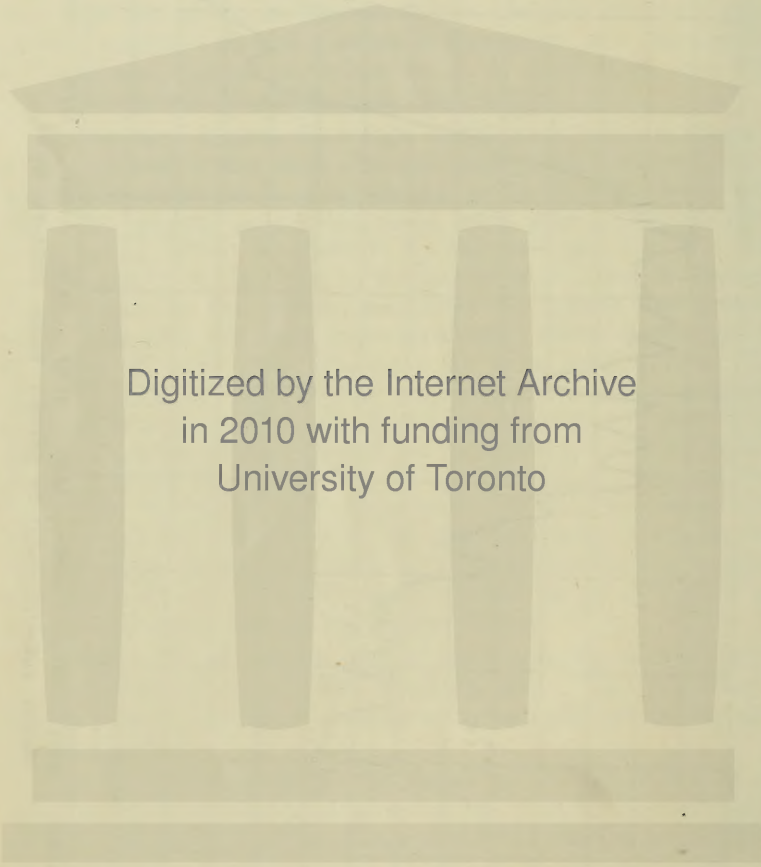
District III, St. Austell, yielded until recently a small output of copper-ore from the South Polgooth mine. The rich lodes of Fowey Consols are largely stoped away and the mines long since abandoned.

District IV consists of the mines in the south-east of the Bodmin Moor granite and includes the Caradon group; these mines are inactive and the chance of their re-opening is considered to be remote.

The area about Hingston Down, Kit Hill and Tavistock is included in District V, where the Devon Great Consols still produces some ore, and also a few tons of precipitated copper. Smaller quantities of copper-ores have been raised at isolated localities, such as Copper Hill near Okehampton and some mines near South Molton in North Devonshire, but these require only a brief description. There were also numerous small producers in Cornwall and Devon, which the limits of space and their relative insignificance render unnecessary to enumerate.



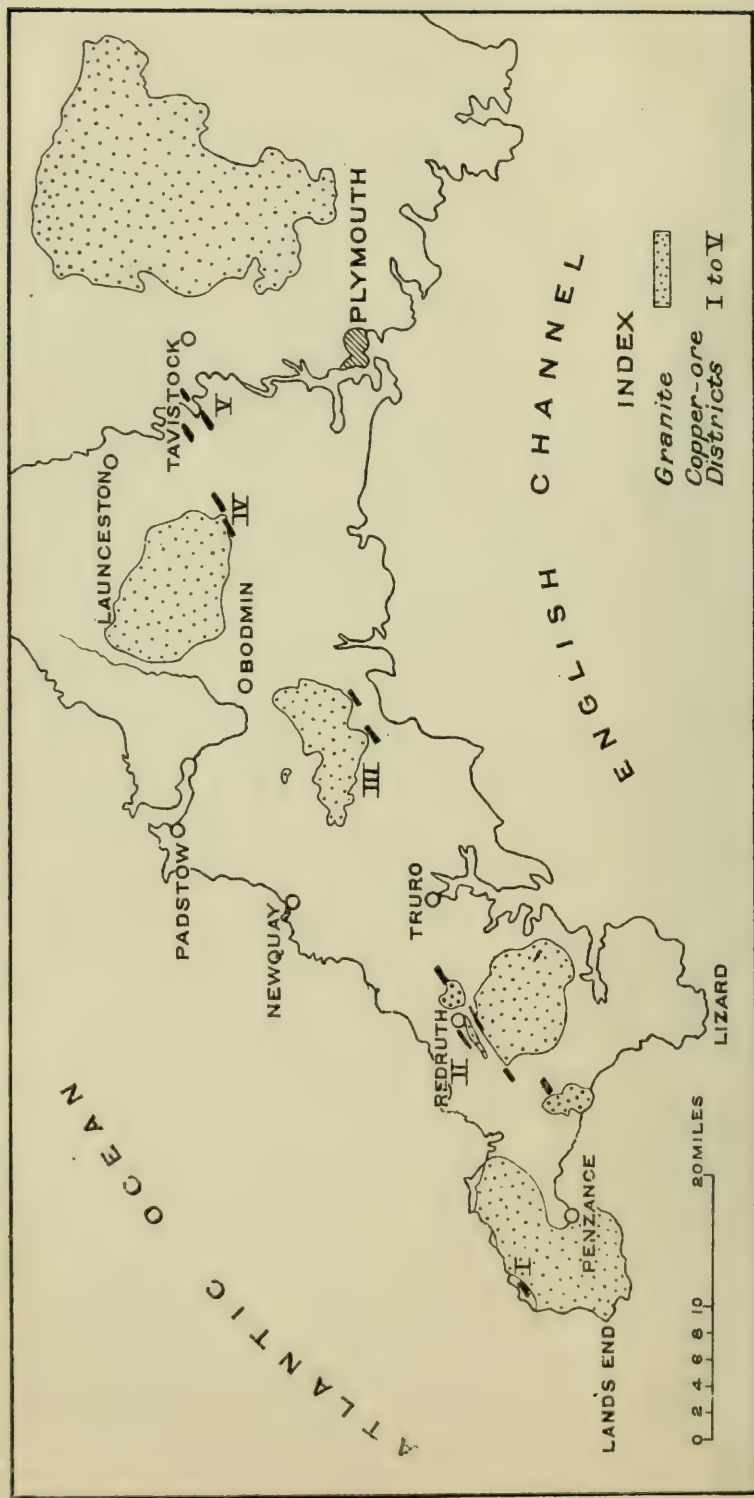




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MAP SHEWING DISTRICTS IN CORNWALL WHERE COPPER-ORES HAVE BEEN RAISED.



## ORIGIN AND MODE OF OCCURRENCE OF THE ORES IN CORNWALL AND DEVON.

As the character of the ores is not specified in the earlier records of copper mining in Cornwall and Devon much important information relating to the origin of the ores is lost; but the more detailed records of mines worked during the middle part of the 19th century show that there were three zones of ores, viz., (1) the uppermost or zone of oxidised ores, (2) the zone of sulphide enrichment and (3) the zone of primary sulphides. The most abundant ore is and always has been chalcopyrite or copper-pyrites, the "yellow ore" of the miner. This occurs in compact masses, sometimes coated with a mammillated and botryoidal crust, or frequently tarnished with brilliant, iridescent colours, when the ore is described as peacock copper. The lodes usually carried a good gossan or 'iron-hat,' sometimes to a depth of 150 fathoms, below which came the black, or less commonly the red oxides, passing downwards into the sulphides. Henwood describes the character of the lodes in the granite and in the killas respectively in the following words: "The *lodes* which yield copper ore in granite almost always contain gossan near the surface . . . . it usually continues to greater depths than it does in slate; as at *Tresavean*, *Ting Tang*, etc. Their quartz is not always so soft (*sugary*) or so minutely divided as in slate, but opens in small irregular masses which yield to a small pressure : . . . . Large quantities of decomposed felspar abound, and the whole is often smeared with a thin and almost impalpable coating of earthy black copper ore : the proportion of this last-mentioned substance often increases in depth, and passes into vitreous copper ore as at *Levant*; and sometimes into copper pyrites, as at *Tresavean*. When the lodes are very granitic, or when they contain much of the schorlaceous quartz, they are seldom productive : indeed copper ores are rarely found imbedded in schorl . . . . The lodes which yield copper ores in slate . . . . contain large quantities of earthy brown iron ore (*gossan*) of a pale hue, soft and *drusy* . . . . Their earthy minerals are mostly quartz, which in the most favourable situations is generally friable (*sugary spar*), sometimes mixed with small quantities of decomposed felspar (*prian*). Near the surface these are spotted with earthy black copper ore, and lower down this is succeeded by vitreous copper ore, and at length by copper pyrites; fluor is occasionally mixed with them as at *Wheal Gorland*, *Unity Wood*, *Wheal Devonshire*, etc."<sup>1</sup>

## CHARACTERS OF THE COPPER ORES.

In Cornwall the zone of enrichment yielded chalcocite or vitreous copper-ore in quantity, but very little of it remains, even

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, pp. 227-228.

at Levant where it formerly constituted the principal ore. Chalcocite is derived from chalcopyrite by secondary enrichment, with a gain of 46 per cent of metallic copper.

Secondary enrichment is a natural process that has been observed at practically all workable deposits throughout the world. The original ores are leached by circulating atmospheric waters which become concentrated and deposit copper in favourable places elsewhere. The copper is dissolved in regions where sulphates or chlorides occur and precipitated from these acid waters by reactions upon the underlying sulphides where oxygen is excluded. This process leads to a vertical zonal distribution of ores, the oxides and carbonates lying in the upper or oxidising layers and the ores of more commercial importance, chalcocite, bornite and chalcopyrite in the deeper parts of the mine. The phenomena of secondary enrichment can often be observed in polished specimens, where chalcopyrite is seen to have been converted into bornite, bornite into covellite, and covellite into chalcocite.<sup>1</sup> These phenomena have been observed at the great copper mines in Arizona, Montana, Mexico, Chili and Peru. In most of these deposits the superficial alteration of copper pyrites yields many secondary minerals and in a fairly definite order; the native metal, sulphates, silicates, carbonates and oxides. Continued action of circulating waters has sometimes carried the oxidised zone downwards into that of secondary enrichment, and less frequently parts may have escaped secondary enrichment and form kernels of inferior material in a richer matrix.

Similar phenomena were observed during the time that the Caradon group of mines, near Liskeard, Cornwall, were being worked. At South Caradon, near the surface, the lodes contained much limonite with melaconite, cuprite, malachite, chersylite and native copper, while at the lower levels chalcopyrite, bornite and chalcocite made their appearance, with considerable quantities of chloritë and fluorspar.<sup>2</sup>

The characters of the country-rocks that are the most favourable for the development of copper-ores have been observed from the early days of mining and are described in some detail by Henwood in his classic work,<sup>3</sup> and by others since his time. All the authors agree that where a lode crosses rocks of different characters its mineral contents change. The principal variation of this kind is where a lode bears cassiterite while in the granite and copper-ores when it enters slate or greenstone. Instances of this change are known around all the granite masses, but it is not an invariable rule, for the reverse was found in the lodes at Wheal Vor. It has also been observed that all sediments are not equally susceptible to the action of emanations that produce copper-ores in lodes. Those which have been found during mining

<sup>1</sup> See W. H. Emmons, 'The Enrichment of Ore Deposits.' Bull. 625 (U.S. Geol. Surv.), 1917.

<sup>2</sup> J. H. Collins, 'The West of England Mining Region,' 1912, p. 253.

<sup>3</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843.



operations to be the most productive are certain "argillaceous slates which accompany the red or variegated slates of the (Gwennap) district and which have a fine grain and a blue-grey colour."<sup>1</sup> Carne<sup>2</sup> records that the killas was most productive of copper-ores in all cases when it was of light blue colour and soft, while Hunt<sup>3</sup> states that "a clay-slate (*killas*) of a pale greyish-yellow hue, passing into a dull white, and here and there marked between the laminæ with a few bluish spots, with internal lamellar structure, but in a state of decomposition, accompanies the richer portions of the copper lodes of Cornwall . . . when they pass through it into a deep blue quartz or killas the mineral deposits either dwindle gradually away or suddenly disappear." It was also observed that copper lodes were frequently enriched in the neighbourhood of elvan dykes.

It appears that where lodes lie in igneous rocks the principal copper-ore is the vitreous variety. It was observed by Henwood<sup>4</sup> to occur in the greenstone at Levant, Botallack and other mines in St. Just, and in the Providence mines and Wheal Trenwith, St. Ives. In the great producing mines between Camborne and Redruth and also at Great Work, Wheal Vor and Wheal Trannack, vitreous copper-ore occurred more frequently in the granite than in the killas. Similarly at Tresavean the lode affords large quantities of copper pyrites in the granite but very little in the slate, and in the same neighbourhood the lodes of Wheal Jewel and East Wheal Damsel produced vitreous copper-ore only where they enter the granite. At Gunnislake also, which is in granite, the vitreous and black copper-ores were almost the only minerals mined.

Hunt<sup>5</sup> notes some remarks made by the late Capt. Charles Thomas on the alignment of the mineral zones in Cornwall and Devon. "If a central line, due magnetic east, be drawn from St. Just on to Tavistock and Exeter, and two other parallel lines be drawn, one north and the other south of this central line, and six miles distant from it, forming a zone of twelve miles in breadth this zone will be found to enclose nearly all the productive mines of tin, lead, or copper in the two counties." . . . "The great mining zone does not follow the granite, but continues in the direction of a right angle to the present magnetic current. And whenever, in that direction, the great beds of secondary granite, compact clay-slate, greenstone, with granular killas and elvan courses are found, there the greatest deposits of copper have been found. . . ."

"In the secondary granite and quartzose micaceous clay-slate nearest the backbone, are the great deposits of tin; in granite

<sup>1</sup> H. T. De la Beche, 'Rept. Geology of Cornwall, Devon and West Somerset,' 1839, p. 335.

<sup>2</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. iii, 1828.

<sup>3</sup> 'British Mining,' 1884, p. 203.

<sup>4</sup> *Op. cit.*, pp. 190-192.

<sup>5</sup> 'British Mining,' 1884, pp. 199, 200 and 202.

a little further removed . . . as well as . . . in greenstone, compact and dark-coloured killas near elvan courses, and in light-coloured and white killas when granular, will be found copper. . . .”

“The following are some of the features of the productive granite: fracture rough and irregular, very jointy, frequently containing hornblende and chlorite, is traversed by irregularly formed elvan courses. . . . That primitive granite contains no metallic ores of value: that tin ores are found nearest to it and copper ores of value never in it, nor very near to it.”

The composition of lodes in different rocks was thoroughly investigated by Henwood<sup>1</sup>, who states “the general law seems to be that a change of rock is characterised by an instant and corresponding alteration in both the metalliferous and earthy minerals of the lodes. . . . In the St. Just district vitreous copper-ore occurs at *Levant*, *Botallack*, *Wheal Cock*, and in most of its mines worked in the greenstone; whilst tin ore is the only produce . . . of all those which are wholly in the granite. In the St. Ives district vitreous copper ore and copper pyrites are almost the only metallic minerals found at *Wheal Trenwith*, *Providence Mines*, and others worked in the greenstone, and slate formation; whilst in granite . . . only tin ore is found. The Gwinear and Crowan district is chiefly in the slate formation, and copper pyrites is the product of the mines in that rock . . . . At *Great Work*, in the Helston district, the passage of *Wheal Breage* lode from granite to slate is attended by the instant disappearance of the tin ore it contained in the former. On the other hand, at *Wheal Vor*, in the same neighbourhood, the lode is productive of tin ore in slate, and becomes utterly worthless in granite.”

“In *Dolcoath*, *Cook's-Kitchen*, *Tincroft*, and the *Cairn Brea Mines*, the lodes in the granite in general contain more tin ore than they do in slate, and frequently more of vitreous, and earthy black copper ores also . . . .”

“In the St. Austell district copper-ores abound in the schistose slate rocks at *Pembroke*, *East Crinnis*, and *Fowey Consols*; but in the quartzose slate of *Polgooth*, the micaceous slate of *Charles-town Mines*, and throughout the granitic tract of that neighbourhood, tin ores only are found . . . .”

“Small quantities of vitreous copper-ore occur in the granite, near its junction with the slate, in *Levant* . . . and some other mines in St. Just; and in similar situations, and mixed with native copper and copper pyrites . . . near St. Ives. At *Great Work* and in *Wheal Vor* a little black copper-ore occurs in the granite; and at *Wheal Trewavas* and *Wheal Trannack*, in the same neighbourhood, vitreous copper-ore and copper pyrites have been plentiful in granite. In the granite of the Camborne district, near the junction of the slate, vitreous copper-ore mixed with copper pyrites has occurred at *Dolcoath*, *Cook's-Kitchen*, *Tincroft* and the *Cairn Brea Mines*. . . .”

<sup>1</sup> *Op. cit.*, pp. 189, 190.



"In *Tresavean* the lode affords enormous quantities of copper pyrites in the granite, but is exceedingly deteriorated on entering the slate; a similar fact presented itself in the adjoining mine of *Penstruthal*. In the same neighbourhood the *lodes of Wheal Jewel* and *East Wheal Damsel* have produced copper pyrites whilst in slate, but vitreous and black copper-ores only when they enter the granite. At *Gunnislake*, which is in granite . . . vitreous and black copper-ores are almost the only metallic mineral. . . ."

"At *Botallack* one of the lodes passes no less than three different times from granite into slate, and at every change, in the granite it yields tin ores only, but wherever it traverses the slate its metallic produce is wholly vitreous copper ore."<sup>1</sup>

In the mineralised area around *Carn Brea* there have been found two series of lodes, which underlie respectively to the north and to the south and differ the one from the other in their mineral contents. Those which underlie to the north are characterised by the abundance of mixed sulphide ores (chalcopyrite, pyrites, etc.) in association with arsenide (mispickel) and tungstates (wolfram and scheelite), but are less rich in cassiterite than those underlying south. The latter on the contrary are poor in sulphides, arsenide and tungstates. Their gangue minerals also present group characters, quartz with schorl occurring more frequently in the north-dipping lodes, while those dipping south consist of chlorite, peach and occasional bunches of fluorspar. Among the lodes which underlie north and contain the sulphide-arsenide-tungstate assemblage may be mentioned, the *South Lode*, the *Great Lode* and the *Rogers Lode* at *East Pool*; the *North Tincroft Lode* and the *North Tincroft South Lode* at *South Crofty* and the *North Tincroft Lode* at *Tincroft*.

## HISTORY.

*De la Beche* gives a short account of the history of copper mining in *Cornwall* and *Devon*.<sup>2</sup> Previous to the beginning of the eighteenth century copper-ores were but little understood, but about 1718 some adventurers from *Bristol* taught the *Cornishmen* the value and the proper method of mining, dressing and smelting the ores. The principal ore was copper pyrites, the next in importance the grey ore and the black oxide respectively, while the blue and green carbonates, the red oxide and the native metal were never of much mining importance. *Pryce*<sup>3</sup> gives an account of the copper-ores sold in *Cornwall* from 1726 to 1775 inclusive; the total amounted in that period to 673,082 tons. *De la Beche*<sup>4</sup> compiled a list of the produce of copper mines between the years 1771 and 1838, omitting the years 1790 to 1793; it amounted to 4,726,739 tons. He says "though it would appear that copper was raised in *Devon* early in the last

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, pp. 192-194.

<sup>2</sup> 'Rept. Geol. Cornwall, Devon and West Somerset,' 1839, pp. 590-608.

<sup>3</sup> 'Mineralogia Cornubiensis,' Introduction, p. xv.

<sup>4</sup> *Op. cit.*, p. 606.

century, it was not until the commencement of the present century that the copper mines in that county became important."<sup>1</sup> He gives a table showing the ore and metal raised chiefly from mines near Tavistock between 1801 and 1837; it amounted to 144,356 tons of ore and 14,730 tons of metal. From these data he deduced that the produce of the ores varied from about 8·2 to 11·2 per cent., and to have been frequently from 9 to 10 per cent. of metallic copper.

At the famous copper mines known as Devon Great Consols serious operations were not started until 1844. From that time until 1903 the sales amounted to over four million pounds sterling.<sup>2</sup> A little previous to this time the group of rich lodes at Caradon had been discovered.<sup>3</sup> The life of the West of England copper mines was calculated by Hunt<sup>4</sup> for a period of 30 years when 35 mines lasted 20 years, 40 mines for 10 years, 31 mines for 5 years, and 114 lasted less than 5 years. The number of mines yielding copper has steadily decreased from 90 in 1863 to 3 in 1918 producing over 40 tons, and several others with smaller outputs. During 10 years ended 1917 Cornwall produced 6,632 tons of ore, equal to 42 per cent. of the total output for England and Wales.

The widths of the copper lodes in Cornwall and Devon were investigated by W. J. Henwood,<sup>5</sup> from whose results the following table is compiled :—

Districts.	Lodes less than 100 fathoms deep.	Lodes more than 100 fathoms deep.	Lodes in granite.	Lodes in slate.	Average width of the copper and tin lodes.
	Feet.	Feet.	Feet.	Feet.	Feet.
St. Just ... ..	2·22	1·62	1·12	1·58	2·23
St. Ives ... ..	1·45	0·5*	1·25	1·22	1·61
Marazion... ..	2·93	—	—	2·93	4·68
Gwinear, etc. ...	1·5	3·07	—	2·11	2·9
Camborne, etc. ...	2·4	—	2·57	—	2·86
Helston ... ..	3·4	3·3	3·14	3·51	3·68
Redruth, etc. ...	3·2	3·5	3·73	3·56	3·36
St. Agnes ... ..	3·55	2·45*	—	2·74	3·09
St. Austell ... ..	3·08	2·68	—	3·2	4·79
Tavistock, etc. ...	9·4	6·57*	—	7·0	6·9
Mean ... ..	3·31	2·96	2·36	3·09	3·61

\* These are from single examples only.

<sup>1</sup> *Op. cit.*, p. 608.

<sup>2</sup> J. H. Collins, 'The West of England Mining Region,' 1912, p. 265.

<sup>3</sup> Webb & Geach, 'History of Mining in the Caradon and Liskeard District,' 8vo. London, 2nd ed., 1863, p. 1.

<sup>4</sup> 'British Mining,' p. 830.

<sup>5</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table CI.

On the whole the lodes which occur in the granite are smaller than those in the slate, the mean width of the former being 3·18 feet and of the latter 3·75 feet.<sup>1</sup> Henwood also found that of 282 lodes 117 dipped north, 90 dipped south, and the rest in other directions. In the St. Just and Gwinear Districts the majority dip south, whereas the opposite is the case in the Camborne and Redruth area, where a large percentage dip north. Of 309 lodes observed, 162 dipped towards the main body of the nearest granite and 111 away from it, the remainder being perpendicular or doubtful. Throughout Cornwall and the west of Devon, the mean dip of the lodes may be about 70° from the horizon.<sup>2</sup>

The maps referred to in the following pages are deposited in the Library of the Geological Survey and Museum, Jermyn Street, S.W.1, and can be consulted there. Most of the six-inch maps are unpublished, but a list of the published maps is printed on p. 69. In the advertisement a list of memoirs dealing with the resources of other minerals will be found (pp. 74-76).

Output in tons of Copper Ore from Cornwall from 1854 to 1917,  
with Copper Precipitate from 1892.

(Compiled from the "Mineral Statistics," 1854 to 1881, the Home Office Returns and from the Cornish Chamber of Mines Year Book, 1918.)

1854	184,858	1876	43,016	1898	5,293
1855	161,576	1877	39,225	1899	5,172
1856	163,958	1878	36,871	1900	5,926
1857	154,336	1879	30,371	1901	4,251
1858	147,330	1880	26,737	1902	4,547
1859	146,093	1881	24,510	1903	5,351
1860	143,789	1882	25,641	1904	4,433
1861	136,954	1883	23,265	1905	4,651
1862	141,800	1884	21,539	1906	3,053
1863	129,229	1885	19,734	1907	2,802
1864	127,633	1886	7,541	1908	1,556
1865	121,253	1887	3,415	1909	1,580
1866	103,670	1888	6,838	1910	870
1867	88,660	1889	4,959	1911	988
1868	86,722	1890	5,271	1912	590
1869	71,790	1891	4,290	1913	421
1870	56,526	1892	2,813	1914	500
1871	46,766	1893	2,673	1915	461
1872	41,902	1894	3,362	1916	605
1873	40,285	1895	5,509	1917	616
1874	40,455	1896	5,616		
1875	39,393	1897	4,140		

<sup>1</sup> *Op. cit.*, p. 241.

<sup>2</sup> *Op. cit.*, p. 247, and Table CII.



Output in tons of Copper-Ore and Copper from Parishes of Cornwall from 1815 to 1905.

"Summary of Progress for 1906" (*Mem. Geol. Surv.*), App. II., p. 134.

Parish	Copper Ore	Copper	Parish	Copper Ore	Copper
Altarnun -	50	5	St. Agnes -	189,500	12,680
Bodmin -	700	45	St. Austell -	80,000	5,200
Breage -	112,000	8,910	St. Blazey -	300,200	26,750
Callington -	2,900	140	St. Breward -	1,000	40
Calstock -	147,400	8,925	St. Cleer -	248,500	24,080
Camborne -	780,000	56,600	St. Erth -	76,900	4,680
Constantine -	8,500	510	St. Ewe -	120	10
Crowan -	213,000	14,840	St. Hilary -	102,700	7,110
Gwennap -	1,593,000	134,700	St. Ive -	37,600	2,590
Gwinear -	88,800	7,970	St. Ives -	33,000	2,540
Illogan -	1,044,400	79,470	St. Just -	147,000	13,990
Kea -	15,800	1,040	St. Mewan -	1,100	85
Kenwyn -	152,600	8,460	St. Neot -	13,200	800
Lanivet -	27,000	1,370	St. Stephen in		
Lanlivery -	150	10	Brannel -	75	5
Linkinhorne -	363,000	25,050	St. Winnow -	4,000	165
Ludgvan -	42,300	3,345	Sithney -	8,500	565
Luxulian -	2,100	240	South Hill -	50	8
Marazion -	41,000	2,910	Stoke Climsland -	76,500	4,440
Newlyn -	540	80	Towednack -	500	50
North Hill -	400	30	Tywardreath -	383,000	30,160
Paul -	40	2	Uny Lelant -	14,400	1,070
Perranuthnoe	35,360	3,050	Wadebridge -	20	5
Perranzabuloe	181,700	11,490	Warleggon -	2,100	140
Phillack -	101,000	6,810	Wendron -	800	50
Redruth -	625,000	54,850	Zennor -	50	5

Output in tons of Copper-Ore from Devon from 1854 to 1917.

(Compiled from the "Mineral Statistics," 1854 to 1881, and the Home Office Returns, 1882 onwards.)

1854	789	1874	12,826	1894	2,314
1855	33,617	1875	14,097	1895	2,008
1856	42,219	1876	16,276	1896	1,588
1857	37,800	1877	16,980	1897	1,417
1858	35,061	1878	12,648	1898	1,084
1859	35,755	1879	12,736	1899	990
1860	35,283	1880	15,760	1900	1,016
1861	35,796	1881	17,133	1901	848
1862	41,513	1882	19,201	1902	350
1863	40,742	1883	18,197	1903	—
1864	37,978	1884	18,074	1904	210
1865	38,156	1885	14,996	1905	834
1866	34,471	1886	10,070	1906	1,117
1867	31,311	1887	5,182	1907	679
1868	30,540	1888	6,935	1908	664
1869	22,723	1889	2,659	1909	443
1870	24,752	1890	6,038	1910 to 1918 }	Nil
1871	24,352	1891	4,039		
1872	24,773	1892	2,818		
1873	16,075	1893	2,471		

Table showing Production of Copper in Tons, in decennial periods, in each of the Countries of the World (compiled from Brown and Turnbull, "A Century of Copper," 1899, pp. 11 to 20.)

Countries.	1801 to 1810.	1811 to 1820.	1821 to 1830.	1831 to 1840.	1841 to 1850.	1851 to 1860.	1861 to 1870.	1871 to 1880.	1881 to 1890.	(8 years) 1891 to 1898.
United Kingdom - - -	65,000	73,000	106,000	143,000	138,000	142,000	116,000	47,000	21,000	4,200
Germany - - -	3,700	3,800	5,800	6,600	8,000	12,600	24,800	65,000	153,000	143,000
Sweden - - -	7,000	6,900	6,000	5,100	6,700	7,200	6,000	6,400	7,900	3,700
Norway - - -	4,800	2,600	4,100	5,700	5,800	5,800	9,000	18,000	21,000	18,000
Other Countries - - -	10,500*	9,700*	13,100*	18,000*	26,400*	50,350*	88,500*	96,000*	231,000*	273,000*
Chili - - -	—	—	—	40,000*	88,000*	214,000	see below	see below	see below	202,000
United States - - -	—	—	—	—	2,400	37,000	97,000	186,000	730,000	1,411,000
South Australia - - -	—	—	—	—	15,700	35,000	71,000	76,000	50,000	44,000
New South Wales - - -	—	—	—	—	—	49	4,700	34,000	51,000	32,000
Spain, and after 1871 with Por- tugal - - -	—	—	—	—	—	2,000*	36,000*	182,000	482,000	434,000
Chili, Bolivia and Peru - - -	—	—	—	—	—	—	447,000	479,000	367,000	—
Japan - - -	—	—	—	—	—	—	—	—	102,000	163,000
Tasmania - - -	—	—	—	—	—	—	—	—	—	9,600
Total - - -	91,000	96,000	135,000	218,400	291,000*	505,999	900,000	1,189,400	2,215,900	2,737,500

\* Estimated quantities.

## CHAPTER II.

## DETAILS OF THE MINES.

## 1. THE ST. JUST DISTRICT.

The productive ground forms a narrow strip, roughly parallel with the coast, extending for a distance of upwards of four miles. The country-rock consists of granite and the adjacent intensely metamorphosed slates and greenstones. There are many important lodes and some other bodies of indefinite form known locally as floors. During the time of formation of the lodes there were successive earth-movements, which broke up the lode-filling into breccia, followed by periods of mineralisation which recemented the fragments. At Levant cassiterite acts as the cement. Large crystals of cassiterite are there seen which were broken up into angular fragments and afterwards recemented with numerous small crystals of cassiterite. Taken as a whole the copper-ore of the St. Just district consists of chalcocite rather than chalcopyrite.

## LEVANT MINE, ST. JUST.

(Active.)

Shafts at Levant, about half a mile north of Botallack and two miles north of St. Just Church.

*Maps* :—One-inch New Series Ordnance and Geological, 351 : Six-inch Cornwall, 67 S.W.

*Memoir* :—‘The Geology of Land’s End,’ pp. 56, 86, 93, 95, 96, 98, 108, 112, 117, 128, 134.

In the existing sett the following mines are embraced :—Wheal Spearn and Spearn Consols, Spearn Moor, Wheal Unity and Levant; only the last-named mine is now working.

The country-rock consists of killas and greenstone metamorphosed by granite. The granite rises to the surface at the Trezise Shaft (Fig. 1), is at 175 fthms depth at the Engine Shaft, 200 fthms at the Skip Shaft (Fig. 2) and, steadily falling towards the west, is just below the 326-fthm. level west of the Skip Shaft. The slope is not even, for the granite rises in large hummocks, and between the 180- and the 210-fthm. levels it actually overhangs. Adit-level is 35 fthms. below the surface.

There are four principal lodes, but only the South Lode (Figs. 1 and 2) and the Prince of Wales Lode are being worked. The Prince of Wales Lode bears N. 72° W., underlies S., and carries an abundance of arsenical pyrites and a good deal of chalcopyrite. At the 300-fthm. level it unites with the South Lode. The South Lode is now the principal lode in the mine and most



of the ores are being raised from it. Eastwards it is continuous with part of the Old Bal Lode. It courses N.  $40^{\circ}$  W., underlies south from surface down to the 230-fthm. level and then north. In parts of its course it is nearly vertical. The 278-fthm. level has been driven seawards for a distance of over 850 fthms.

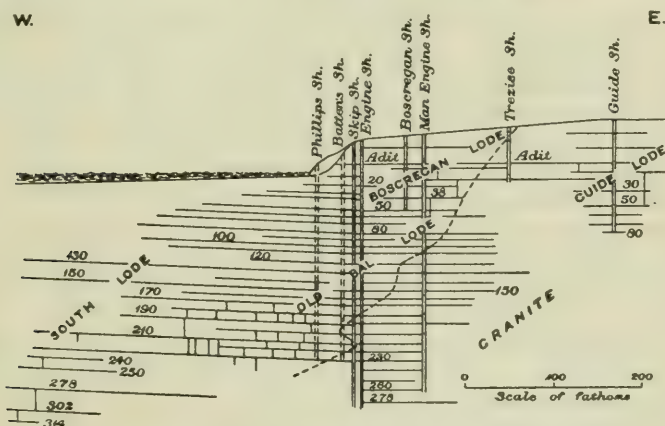


FIG. 1. *Levant Mine. Longitudinal section shewing levels and workings.*

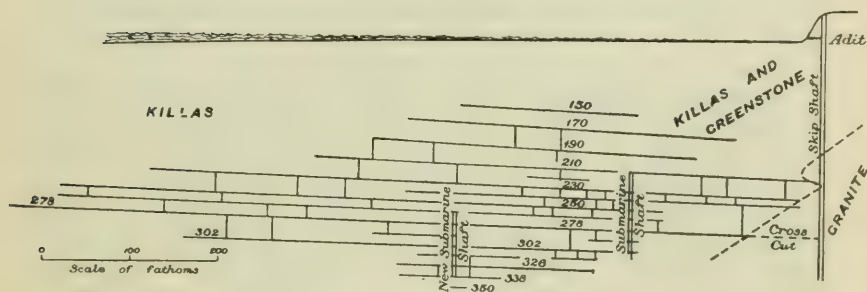


FIG. 2. *Levant Mine. Workings in Main (or North) Lode.*

The South Lode is the most productive for copper-ores, but has yielded the bulk of them below the 278-fthm. level, where it has a northerly underlie. In July, 1918, tin-, copper- and arsenical-ores were being mined at the 314-, the 326-, the 338-, and the 350-fthm. levels; all in workings that lie to the west of the New Submarine Shaft.

East of that shaft most of the ore consists of cassiterite and very little copper-ore is raised.

The North Lode, Old Bal Lode, and South Lode, unite at a distance of 35 fthms. east of the New Submarine Shaft, and 315 fthms. west of the coast.

The South Lode in its upper parts contains large quantities of earthy red and brown hæmatite, yellow and grey copper-ores and cassiterite in leaders, veinlets or 'squats.' In its deeper parts

there is less hæmatite, but a more intimate association of cassiterite, quartz and ores of copper. In some of the deep workings and especially at the 338-fthm. level, chalcopyrite and a cinnamon-coloured garnet are closely intermixed to form a rock described by the miners as 'spelter.' Henwood<sup>1</sup> records the distribution of the ore down to the 140-fthm. level. In the upper levels there was much earthy red iron-ore, with some vitreous copper-ore. At the 94-fthm. vitreous copper-ore increased in quantity greatly and there were large quantities of it at the 144-fthm. level. The characteristic of the lodes of this mine is their intensely hard and highly silicified walls, which require special means of stoping. Most copper-ore now comes from west of the New Submarine Shaft; and the best tin ground lies about 500 fthms. west of the coast between the 278-fthm. and the 350-fthm. levels.

The North Lode lies next to the South; it meets and cuts across the South Lode, but becomes poor west of it and was not followed. It courses about W.  $28^{\circ}$  N. and underlies at  $20^{\circ}$  S. The lode in the granite is poor, but has been long worked in the greenstone or iron-killas, where, at the 200-fthm. level, the chalcopyrite is associated with garnets.

The Shop Lode courses north and south and underlies to the west. It consists mainly of limonite and quartz, with vitreous copper-ore at depth.

The Old Bal Lode hades north at  $20^{\circ}$ , and courses from N.  $30^{\circ}$  W. to N.  $23^{\circ}$  W. In the old part of the mine it was the main lode, but seawards it has not been much worked. Its southern branch becomes part of the South Lode.

The mine has been worked for a distance of  $1\frac{1}{4}$  miles from the coast and down to a depth of 360 fthms. Although most of the levels are under the sea the mine is remarkably dry, but in the lowest workings the air is hot, the temperature being  $91^{\circ}$  F.

The mine is worked by many submarine levels and two submarine shafts, and the Engine Shaft which is situated near the edge of the cliffs. The old Submarine Shaft lies about 220 fthms. from the Engine Shaft and is sunk from the 210-fthm. level down to the 302-fthm. The New Submarine Shaft lies about 200 fthms. further to the west and connects the 260-fthm. with the 350-fthm. level. The levels extend westwards from the New Submarine Shaft for a distance of about 500 fthms.

Most of the productive ground in Levant lies in the greenstone and the killas country and the lodes become impoverished in the granite. The lodes are narrow in comparison with many others in Cornwall, but contain a variety of minerals, including bismuth, bismuthinite, carbonate of bismuth, malachite, native copper and silver, fahlerz, arseniate of iron, aragonite, göthite, garnet, gypsum, native silver, scheelite, tetrahedrite, cuprite, cassiterite and mispickel.<sup>2</sup>

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table IX.

<sup>2</sup> 'The Geology of the Land's End District' (*Mem. Geol. Surv.*), 1907, pp. 108-109.

In treating the mixed ores by calcination the sulphur eliminated is in part recovered in flue-tanks and made into sulphuric acid, used for precipitating copper on scrap-iron.

The output in recent years has been about 125 tons of rough copper-ore and 45 tons of copper precipitate per annum. The precipitate averages about 60 % of metallic copper.

The yield of copper averages from 5 to 6 lbs. per ton of ore treated, but a good deal of the larger pieces are hand-picked.

The output between 1820 and 1841 and from 1845 to 1905 amounted to 115,400 tons of ore, yielding 10,775 tons of metallic copper.

### BOTALLACK MINE, ST. JUST.

(*Idle.*)

Shafts at Botallack nearly a mile north of St. Just Church-town.

*Maps*:—One-inch New Series Ordnance and Geological, 351 : Six-inch Cornwall, 67 S.W.

*Memoir*:—‘The Geology of Land’s End,’ pp. 93, 95–98, 102–104, 124, 134.

The sett includes Wheal Cock, the Crowns Mine, Truthwell, Carnyorth, Wheal Owles and Botallack.

The country-rock is granite, overlain west of the Engine Shaft by metamorphosed greenstone or iron-killas and a narrow strip of altered slate.

The lodes have been worked under the sea for a distance of nearly 600 yards. They were remarkably rich and contained a great variety of minerals and often presented unusual modes of occurrence. The cupriferous minerals included vitreous copper-ore, atacamite, black and purple copper-ore, blue carbonate of copper, malachite, native copper, cuprite, fahlerz, and copper pyrites.

The principal lode is the Narrow or Crowns Lode; it varies in width from 2 to 12 feet; the other lodes are small. The bearings of the lodes differ, but their general trend is north-westerly.

In working the mines the richest zones were followed and as these occur near the junction of the granite with the killas and greenstone, the workings deepened seawards and in a direction parallel with the surface of the granite.

Botallack has been worked to a depth of 240 fthms.; Carnyorth to a depth of 123 fthms. below adit (26 fthms.); while at Wheal Cock the workings were in 1778 over 100 fthms. deep and far out beneath the sea.

The statistics of production from these mines are incomplete, but according to J. H. Collins<sup>1</sup> the copper-ore sales from 1815 to 1856 amounted to 21,564 tons.

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<sup>1</sup> ‘The West of England Mining Region,’ 1912, p. 421.



## MELLANEAR MINE, ST. EARTH.

(Idle.)

The shafts are situated about  $\frac{3}{4}$  mile south of Hayle station (G.W.R.).

*Maps*:—One-inch New Series Ordnance and Geological, 351 : Six-inch Cornwall, 69 N.W.

*Memoir*:—‘The Geology of Land’s End,’ pp. 98, 113, 128, 134.

The country-rock consists of Lower Palæozoic slates and sandstone (the Mylor Series); with an elvan dipping north.

There are two lodes known respectively as the Main Lode and the North Lode. They both course E.N.E. and underlie N.N.W. at a high angle. They are continuous with the lodes worked at the Alfred Mines. The lodes contained copper pyrites, iron pyrites, some tinstone and a good deal of zinc blende.

The mine has been worked to a depth of 100 fthms. and was closed down in 1889.

The output from 1866 to 1888 amounted to 66,311 tons of copper-ore and 3,965 tons of metallic copper. Between 1815 and 1864 the neighbouring Wheal Alfred and Alfred Consols had an output of 64,200 tons of copper-ore.

The St. Earth and Gwinear District covers an area of about twelve square miles, lying mainly between Hayle and the Godolphin granite. There are many disused copper mines, of which several were large producers, but few were worked to a greater depth than about 200 fthms. It has been essentially a copper district, but the ore was always developed in bunches and patches and not in continuous lodes. The country-rock consists chiefly of clay-slate with dykes of elvan and masses of greenstone and is characterised in places by its highly brecciated condition.<sup>1</sup> In the Gwinear Consols Mine “smooth pebbles of granite of several pounds in weight were met with in the lode 100 fthms. beneath the surface and nearly three miles from the granite country.”<sup>2</sup> The lodes course generally in an east-north-east direction, but some to the south of Gwinear Downs are nearly east and west. As it is not generally considered likely that the deeper mines would pay to reopen, the following table of the principal mines of these districts is given without details, which can be obtained from the undermentioned publications.<sup>3</sup> Mines with a total output of less than 9,000 tons of ore are omitted.

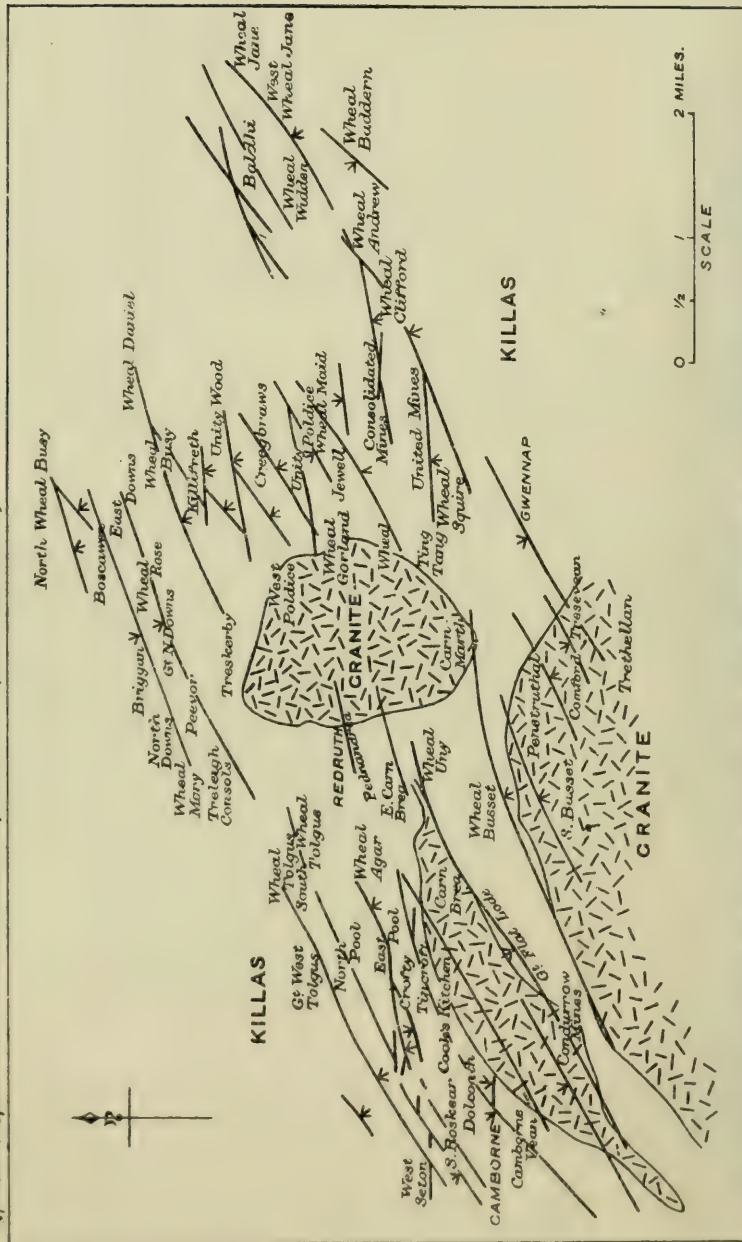
The output from all the mines in the St. Just District amounted to 133,400 tons of copper-ore and 13,370 tons of copper. From the districts of Gwinear and St. Hilary the output was 353,000

<sup>1</sup> C. Thomas, *Mining Fields*, 1867.

<sup>2</sup> Thomas, *Op. cit.* See also W. W. Rundell in *Trans. Roy. Geol. Soc. Cornwall*, vol. vii, 1865, p. 37.

<sup>3</sup> J. H. Collins, ‘Observations on the West of England Mining Region,’ *Trans. Roy. Geol. Soc. Cornwall*, vol. xiv, 1912, and ‘The Geology of the Land’s End District’ (*Mem. Geol. Surv.*), 1907.





MAP OF THE PRINCIPAL LODES AND MINES IN THE CAMBORNE, REDRUTH AND SCORRIER DISTRICTS.

24550/750/2.29.

C&R. L<sup>to</sup> 978.



tons of copper-ore and 28,500 tons of copper. The districts of St. Ives and Penzance had a total output which amounted to 74,000 tons of copper-ore and 6,000 tons of copper. The total for all these districts was, therefore, 557,000 tons of ore and 47,600 tons of metallic copper.<sup>1</sup>

List of Mines not included in the foregoing pages, with total outputs exceeding 9,000 tons of copper-ore.

Mine.	Parish.	Six inch Map : Cornwall.	Output in tons Copper ore.	Output in tons Copper.	Date.
Alfred, Wheal -	Phillack -	69 N.W.	64,200	4,810	1815-1832 } 1846-1864 }
Alfred, Gt. Wheal	Phillack -	69 N.W.	21,510	1,144	1852-1863
Binner Downs -	Crowan -	69 S.E.	51,100	3,770	1819-1838
Caroline, Wheal -	Perranuthnoe	75 N.W.	9,830	630	1826-1831
Darlington, Wheal	Ludgvan -	68 S.E.	18,900	1,405	1833-1845
Friendship, Wheal	St. Hilary -	69 S.W.	17,080	1,597	1815-1819 } 1849-1855 }
Guskas & Anna -	St. Hilary -	69 S.W.	9,127	520	1852-1866
Halamanning and					
Croft Gothall and	St. Hilary -	75 N.W.	13,400	885	1851-1858
Retallack - -	St. Hilary -	75 N.W.	9,550	640	1832-1836
Herland, Wheal -	Gwinear -	69 N.E.	18,520	2,000	1816-1843
Marazion Mines -	Marazion -	74 N.E.	30,000	2,222	1830-1841
Margery, Wheal -	St. Ives -	61 S.E.	16,400	840	1854-1870
Neptune, Wheal -	Perranuthnoe	75 N.W.	13,760	1,400	1815-1838
Prosper United -	St. Hilary -	69 S.W.	22,500	1,020	1863-1872
Prosper, Wheal -	Ludgvan ?	68 S.E.	14,600	956	1832-1835 } 1845-1849 }
Providence, Wheal	Gwinear -	69 N.W.	15,260	1,314	1820-1847
Providence Mines			10,030	768	1836-1855
Relistian Consols -	Gwinear -	69 N.E.	12,150	1,032	1832-1842
Retallack - -	St. Hilary -	75 N.W.	10,020	940	1831-1836
Rosewarne and					
Herland and					
Rosewarne United	Gwinear -	69 N.E.	14,480	1,200	1854-1874
Speedwell, Wheal	Breage -	75 N.W.	11,360	870	1819-1854
Strawberry, Wheal	Crowan -	69 S.E.	9,750	575	1830-1837
Tolvaddon - -	Marazion -	74 N.E.	10,750	670	1857-1866
Trenwith, Wheal -	St. Ives -	61 S.E.	13,080	1,450	1825-1856
Trewavas - -	Breage -	75 S.E.	17,400	1,414	1836-1846
West Wheal					
Treasury - -	Crowan -	69 S.W.	9,500	724	1845-1854

## II. THE CAMBORNE, REDRUTH AND SCORRIER DISTRICTS.

In these districts (Plate III) are included the principal mineral areas lying near the Carn Brea and the Carn Marth granite masses. Most of the greatest producers of copper-ores in the past lie in

<sup>1</sup> 'The Geology of the Land's End District' (*Mem. Geol. Surv.*), 1907, p. 122. These totals, quoted from the memoir, do not cast.

this area and include such groups of mines as the Basset, the Seton, the Roskear, the Condurrow, the Buller, the Poldice, the Clifford Amalgamated, the Pool, Peevor United, the Tolgus, the Crofty, Tresavean, Tincroft and Dolcoath. The series of lodes worked in these mines occur both in the granite and in the metamorphosed rocks adjacent to it. The distribution of the ores both in depth and laterally has already been described on p. 6. At Tresavean, copper-ores are still being raised in fair quantities and from abnormal depths, while the impoverished zone and the zone of cassiterite beneath it have both been proved.

In the St. Agnes area the mines are almost exclusively tin mines, but on proceeding south-westwards towards Porth Towan the lodes become productive of both tin and copper, while at Porth Towan they were practically worked only for copper-ore. The lodes in this district have a general southerly underlie and an average strike of E.  $20^{\circ}$  N. North of St. Agnes is situated Wheal Prudence, a mine principally wrought for copper-ore. The lodes may be regarded as belonging to the series worked in the Perran St. George and Wheal Leisure mines at Perranporth, striking E.  $20^{\circ}$  N.<sup>1</sup> Beyond the record of output, given on p. 19 but very little has been published about these mines.

GOOD FORTUNE, PART OF ST. GEORGE AND DROSKYN,  
PERRANZABULOE.

(*Idle.*)

The shafts are situated near Cligga Head.

*Maps* :—One-inch New Series Ordnance and Geological, 346 : Six-inch Cornwall, 48 N.W.

The country-rock consists almost entirely of killas, but an elvan traverses the sett.

The Main Lode branches into the North and South Lodes. Both lodes underlie north.

At the Droskyn Mine, Perranporth, the adit-level is at 10 fthms. and the lowest workings at 40 fthms. below the adit.

At the Great St. George and Wheal Leisure Mines there are three lodes. The South Lode bears E.  $5^{\circ}$  N. and varies in width from two to five feet. From the 36- to the 46-fthm. level the lode underlies S.  $30^{\circ}$  to  $50^{\circ}$ . It consists of earthy brown iron-ore, black and vitreous copper-ore and iron and copper pyrites with quartz.

Calloway's Lode bears east and west and is from one to two and a half ft. wide. From the 26- to the 46-fthm. levels it underlies N.  $45^{\circ}$  to  $60^{\circ}$  and contains copper pyrites, iron pyrites and quartz, with purple and vitreous copper-ore.

Kernick's Lode bears E.  $20^{\circ}$  N., underlies south  $4^{\circ}$  to  $50^{\circ}$  and varies from half a foot to twelve ft. in width. It consists of quartz, copper pyrites, black and vitreous copper-ore, iron pyrites and zinc blende. The output of copper-ores from these mines is given on p. 19.

<sup>1</sup> D. A. MacAlister in 'The Geology of Newquay' (*Mem. Geol. Surv.*), 1906, pp. 91, 92.

## PRUDENCE, WHEAL, ST. AGNES.

(Idle.)

The shafts are situated on the coast about one and a half miles north-east of Trevaunance Cove.

*Maps*.—One-inch New Series Ordnance and Geological, 346 : Six-inch Cornwall, 47 S.E.

The country-rock consists of killas with an elvan in the lower workings of the mine.

There are many lodes, most of them being nearly vertical. Henwood<sup>1</sup> gives the following particulars of the North Lode the South Lode and the Caunter Lode :—The North Lode courses E. 35° N. and varies in width from 6 inches to 2 ft. From the 80- to the 110-fthm. level the underlie varies from N. 10° to N. 22°. The lode consists of quartz, slate, copper and iron pyrites and some blende and cassiterite.

The South Lode courses E. 30° N. From the 47- to the 110-fthm. level the lode underlies south from five to twenty-two degrees, and varies in width from 1½ to 10 ft. It consists of quartz, fragments of slate, iron and copper pyrites with blende and some cassiterite.

The Caunter Lode courses E. 20° S., dips south from 5° to 10° and is one foot to eighteen inches in width. It consists of quartz with copper pyrites.

For output, *see* below.

List of Mines in St. Agnes and Perranzabuloe, not included in the foregoing pages, with total outputs exceeding 2,000 tons of copper-ore :—

Mine.	Parish.	Six-inch Map : Cornwall.	Output in tons Copper ore.	Out- put in tons Cop- per.	Date.
Charles, Wheal -	St. Agnes -	56 N.E.	4,300	285	1821-1834
Charlotte, Wheal -	St. Agnes -	56 N.E.	23,010	1,950	1820-1856
Great St. George and Droskyn -	Perranzabuloe	48 N.W.	71,000	4,650	1815-1840
Great Wheal Leisure . - -	Perranzabuloe	48 N.W.	27,400	1,365	1832-1836 }
					1852-1853 }
Leisure, Wheal -	Perranzabuloe	48 N.W.	29,900	2,370	1829-1832 }
					1840. }
Perran, Wheal -	Perranzabuloe	48 N.W.	3,200	250	1834-1842
Perran and Great Wheal Leisure -	Perranzabuloe	48 N.W.	4,550	145	1854-1855
Perran St. George	Perranzabuloe	48 N.W.	32,125	1,800	1845-1860
Perran United -	Perranzabuloe	48 N.W.	7,700	250	1853-1857
Prudence - -	St. Agnes -	47 S.E.	7,000	400	1821-1865
Rose, Wheal -	Perranzabuloe	48 N.W.	6,360	435	—
Towan, Wheal -	St. Agnes -	56 N.E.	26,100	1,465	1815-1835
Tywarnhayle -	St. Agnes -	56 N.E.	32,400	1,745	1848-1869

<sup>1</sup> 'On the Metalliferous Deposits of Cornwall and Devon,' *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table LXXX.



## DOLCOATH MINE, CAMBORNE.

(Active.)

Shafts at Dolcoath five-sixths of a mile north-east of Camborne station.

*Maps*:—One-inch New Series Ordnance and Geological, 352: Six-inch Cornwall, 63 S.W.

The sett (Fig. 3 and Plate IV)<sup>1</sup> comprises the old mines of Wheal Harriet, Dunkin's Garden, Stray Park, Wheal Gons and Dolcoath. The mine has been worked for over one and a half centuries. In 1758 it was 88 fthms. deep, in 1824, 240 fthms., in 1868, 340 fthms., while at the present time a depth of 540 fthms. below adit has been attained. The country-rock consists of metamorphosed slate and sandstone overlying granite. In the eastern part of the mine the granite lies at a depth of 110 fthms. below the surface, while in the western part the depth increases to 260 fthms. There are also several elvan dykes, especially in the lower workings of the mine.

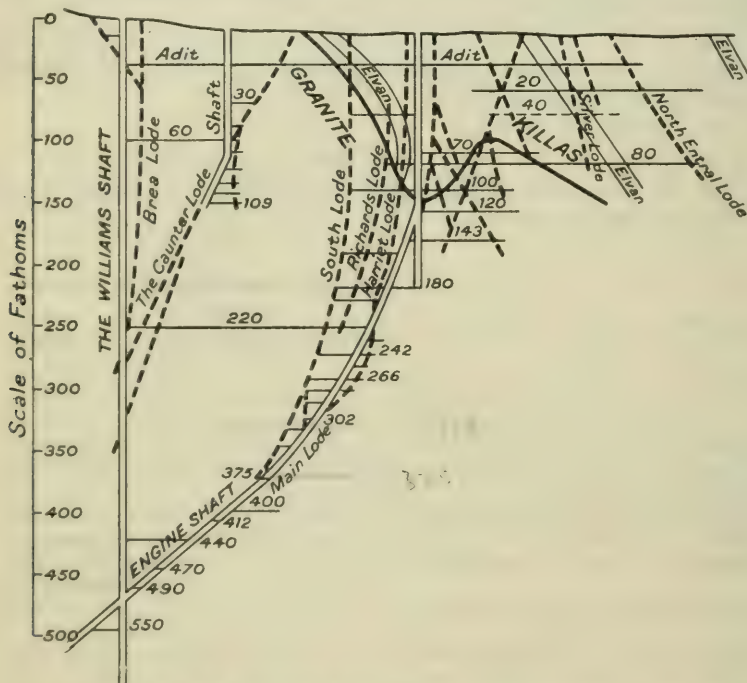


FIG. 3. Dolcoath Mine. Transverse section.

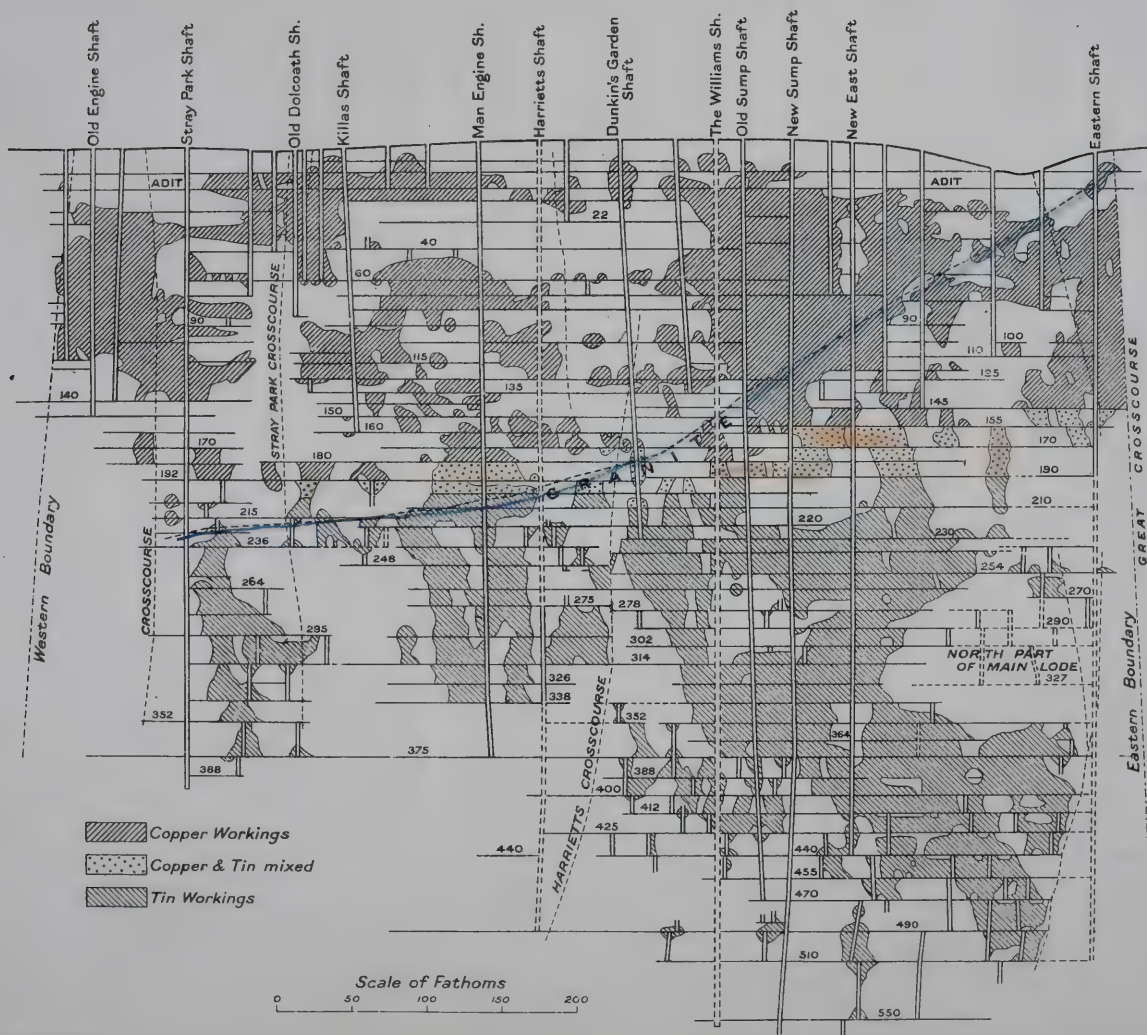
The principal lode is the Main Lode. It is vertical to the 80-fthm. level, thence to the 125-fthm. level the underlie is from  $6^{\circ}$  to  $7^{\circ}$  south, while between the 125- and the 216-fthm.

<sup>1</sup> These sections have been drawn up from those published by the Dolcoath Company.

## W.

SECTION OF THE MAIN LODGE.

E.







it is about  $15^{\circ}$  south; it increases to  $44^{\circ}$  south at the bottom of the mine. The lode varies in thickness from 3 to 12 feet. It had a fine gossan and was exceedingly rich in copper-ore down to the 150-fthm. level. From this level to the 190-fthm. both copper and tin-ores occurred, but below the 190-fthm. copper-ore became rare (Plate IV). This lode was also very rich in copper-ore down to the 124-fthm. level in the Stray Park section of the mine.

Harriett's Lode has a bearing of E.  $20^{\circ}$  N. down to the 180-fthm. level, but below that level it gradually changes to E.  $40^{\circ}$  N. In the eastern part of the mine it unites with the Main Lode and there large quantities of copper-ore were found. It had a poor gossan and yielded no copper-ore above the 110-fthm. level, but down to the 180-fthm. good values were obtained.

The North (or Valley) Caunter underlies  $5^{\circ}$  S. and varies from 6 to 10 ft. in width. At its junction with the South Entral Lode it is up to 60 ft. in width. The lode contained enormous quantities of copper-ore between the 20- and the 130-fthm. levels, but was poor below that depth.

The South Entral Lode is situated on the north of the Main Lode and courses nearly parallel with it. It underlies south at  $13^{\circ}$ , and varies from 1 ft. to 3 ft. in width. Copper-ore occurred from adit down to the 50-fthm. level. The Caunter Lode breaks off from the Main Lode, bears E.  $4^{\circ}$  S. and underlies  $15^{\circ}$  south. In width it varies from a half to one ft.; it was very rich in copper-ore from adit down to the 80-fthm. level for a distance of 150 fthms. east of the Main Lode.

The copper-ores were locally associated in this mine with ores of uranium, cobalt, nickel and bismuth and sometimes with silver.

Until recent times small quantities of copper-ore were being raised, and mainly in the eastern parts of the mine between the 60- and the 120-fthm. levels.

The mine plans and sections (Plate IV) show that the copper-ores are not confined to the killas, but occur in a zone roughly parallel with the surface and in both the killas and the granite. The base of this zone lies at about 190 fthms. below the surface.

Records of output previous to 1815 are untrustworthy and those since that date are often imperfect. Phillips<sup>1</sup> states that between the years 1815 and 1856, 241,522 tons of ore containing 17,478 tons of metallic copper were sold by public ticketing. Copper-ore amounting to 38,610 tons was sold from the Stray Park Mine.

Since 1906 the output has been as follows:—in 1907, 15 tons; 1908, 172 tons; 1909, 88 tons; and 1910, 37 tons. The reserves are held to be small.

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<sup>1</sup> J. A. Phillips, and J. Darlington, 'Records of Mining and Metallurgy,' (*Spon, Lond.*), 1857.

## THE SETON MINES, CAMBORNE.

(Idle.)

This group of mines includes from east to west the Old Pool, North Wheal Crofty, North Roskear, South Roskear, Wheal Seton, West Wheal Seton and New Seton.

*Maps* :—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.W. and S.W.

The country-rock consists of metamorphosed killas penetrated by dykes of elvan and sills of greenstone.

The principal source of ore in this group was the Great Wheal Seton Lode, which for part of its course was known as the Great Caunter (Figs. 4 and 5). At North Crofty the lode was known as Reeve's Lode; it bears nearly due east and west and underlies north from one in three to one in four. In Pool an elvan intersects the lode at various levels. Although rich deposits of copper-ore were found in ground lying above the elvan, very little occurred below it. At the 170-fthm. level cassiterite appeared in quantity and continued down to the 200-fthm., where work was discontinued.

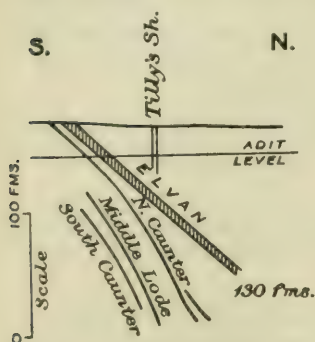


FIG. 4. Wheal Seton.  
Section at Tilly's Shaft.

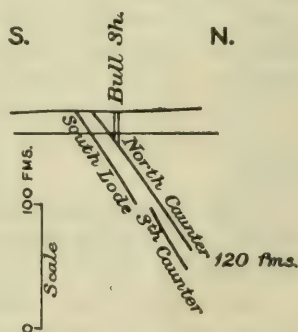


FIG. 5. Wheal Seton.  
Section at the Bull Shaft.

At North Roskear a cross-course heaves the lode slightly. In this mine and in South Roskear copper-ores were abundant in the upper levels down to about 180-fthms. from the surface and continued to occur in small quantity down to the 285-fthm. level. Mispickel was abundant between 100 and 132 fthms. below the surface. Tin-ore was first seen at depths of 100 to 150 fthms.

In width the lode varies laterally and in depth; at 205 fthms. it was  $2\frac{1}{2}$  ft. wide and consisted of copper pyrites and tin-ore in a quartzose gangue. At 216 fthms. it ranged from 1 to 8 ft. and contained fluorspar and chlorite in addition to copper- and tin-ores.

The North Roskear Lode bears E.  $32^{\circ}$  N., underlies from  $8^{\circ}$  to  $22^{\circ}$  N., and is up to 5 ft. wide. It consists of copper and iron pyrites with fluorspar, chlorite and quartz.

The South Lode bears E.  $32^{\circ}$  N., underlies from  $45^{\circ}$  to  $50^{\circ}$  N. at the 37-fthm. level and from  $6^{\circ}$  to  $36^{\circ}$  S. at the 57-fthm. It contains copper and iron pyrites and blende in a quartzose gangue. The Main Lode underlies N. at  $35^{\circ}$  to  $40^{\circ}$  and averages about a foot in width. Its gangue is soft killas, with much mundic.

Of the seven parallel lodes in South Roskear only the South Roskear and the North Entral were worked.

The Great Wheal Seton Lode is heaved 20 to 30 fthms. to the right by the Great cross-course in Wheal Seton. It pursues its normal course, however, for another 80 fthms. and then curves round to about  $40^{\circ}$  south of west. It continues thence through West Wheal Seton to New Seton, beyond which it has not been traced.

A greenstone was encountered at the 135-fthm. level in Wheal Seton, in which, contrary to the normal character, the lode became greatly enriched. At various depths in this mine the lode contained an intimate admixture of tin- and copper-ores.

The lode continued to be rich at West Seton, but at New Seton was so impoverished that further exploitation in a south-westerly direction was abandoned. At West Seton the lode divided into the North and the South Lodes, while another lode, nearly vertical, yielded some copper-ores.

In general the characters of this lode were well defined. It maintained throughout its course an average thickness of 6 ft. and yielded from 4 to 10 tons of copper-ore to the fthm. In addition to this uniform richness, two exceptionally rich shoots of ore were found, one on the east, which extended for a length of 300 fthms. and a depth of 40 fthms., and the other, in the western portion of the lode, extended 120 fthms. in length and 40 fthms. in depth.

Tin-ore began to appear at about 90 fthms., but the rich tin zone was not reached when the mines were abandoned.

The output or quantity of copper-ores sold and the tonnage of copper they contained is given in the following statistics from Collins and MacAlister:—

Name of Mine.	Tons of Copper-ore.	Tons of Metallic Copper.	Periods.
East Wheal Seton -	1,720	122	1847-1875
North Roskear - -	151,800(sold)	11,850	1816-1856
North Roskear - -	15,600 „	1,155	1857-1874
Wheal Seton - -	113,050	7,080	1838; 1845-1877
South Roskear - -	37,807(sold)	2,904	1821-1850
West Wheal Seton -	114,450	9,300	1848-1890



## EAST POOL AND AGAR (WITH CARN BREA), ILLOGAN.

*(Active.)*

Shafts at Pool midway between Redruth and Camborne.

*Maps* :—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.W.

Down to the 135-fthm. level the country-rock consists of killas and greenstone, but below that level the lodes are in granite. The mine has yielded enormous quantities of copper-ore as well as cassiterite and wolfram. During the period between 1835 and 1856 over 2,900 tons of metallic copper were produced from 38,700 tons of ore, showing an average of 7·5 per cent. of metal; as the mine became deeper inferior ore, averaging 5·1 per cent., was obtained. At present dry-assays indicate from 10 to 14·7 per cent. of metal.

Copper-ores occur down to about 140 fthms. below the adit level, often in company with fluorspar. The principal lodes underlie either to the south or to the north. The lodes underlying north are richer than the others and contain less peach. The copper-ores are accompanied by arsenical pyrites from the surface down to their lowest limits.

From the south of the sett northwards the New South Lode, the Engine Lode series and the Middle Lode underlie south; while the South Lode or Great Lode with its spurs and branches, the Rogers Lode, and the Trembath Lode incline north. All the lodes bear copper-ores. The adit level is 16 fthms. below the surface. The Main Lode or Engine Lode series comprises the Caunter, the Engine, Palmer's and Pryce's Lodes. The underlie down to the 36-fthm. level is 15° S. At this level the lode meets an elvan that dips north, below which the lode is perpendicular down to the 60-fthm. level, where it resumes its underlie of 15° S. The lode had a good gossan and yielded copper-ore in abundance down to the 150-fthm. level. Palmer's Lode contained much copper-ore from the 26- to the 48-fthm. level for a distance of 30 fthms. in the direction of its strike.

The South Lode has numerous spurs and branches, but none of them of great importance; they include the Copper Lode, the Red Lode, the Gingerpop Lode, and two others without names. It bears parallel with the Main Lode, underlies N. 20°, and varies in width from 1 to 30 ft. At adit-level it consisted mainly of flucan and quartz; it yielded copper-ores from the 40- to the 70-fthm. levels, and copper- with tin-ores from the 70- to the 100-fthm. levels. Copper-ores were again abundant at the 130-fthm. level, where the lode also contained tin-, wolfram- and arsenic-ores.

Rogers Lode, with its upper branches Dobree's and North Lodes, underlies to the north. The South, the Great and Rogers Lodes are regarded as one lode which has been displaced by faults.

J. H. Collins<sup>1</sup> inferred that the lode now called Rogers Lode would be encountered by cross-cutting: an inference which was substantiated in 1915 by the discovery of this rich lode.

The quantity of ore sold between the years 1835 and 1903 amounted to 93,090 tons and contained 5,687 tons of metallic copper. At Carn Brea 158,200 tons of copper-ore were sold between 1833 and 1905. The following figures show the output of copper-ore in recent years:—

Tons.			Tons.			Tons.		
1906	-	31	1910	-	12	1914	-	21
1907	-	68	1911	-	16	1915	-	16
1908	-	23	1912	-	23	1916	-	11
1909	-	25	1913	-	21	1917	-	5

#### SOUTH CROFTY (WITH NEW COOK'S KITCHEN), ILLOGAN.

(Active.)

Shafts at Pool, south of the road from Redruth to Camborne and west of that from Pool to Four Lanes.

*Maps*:—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.W.

The mines in this sett comprise New Cook's Kitchen, West Wheal Crofty, Longclose, South Wheal Crofty and East Wheal Crofty.

The country-rock consists of killas overlying granite.

There are many lodes in the sett, but some of them are not being worked. The principal lode of the district, the Great Lode, has long been worked for copper-, tin-, wolfram- and arsenic-ores and still yields good returns.

The principal sources of copper-ore at present are the Middle Lode and the North Tincroft Lode; the ore raised is nearly all chalcopyrite, with some peacock copper. From south to north the following lodes cross the property in a general east-north-east direction and underlie either to the north or to the south:—

North Tincroft Lode underlies north at about 50° down to the 130-fthm. level, below which it is nearly vertical. Pryce's Lode, or the Engine Lode of East Pool, underlies south at 65° bears E. 15° N. and joins the South Lode at the 205-fthm. level. It consists mainly of copper-ores down to the 100-fthm. level with a gangue of blue capel, peach, quartz, fluorspar and chlorite. The Middle Lode, the principal producer of copper-ores at the present time, is nearly vertical, with a slight northerly underlie, it contains much fluorspar and iron-pyrites. At the 260-fthm. level it joins the North Lode. The Great Lode also underlies north but is nearly vertical down to the 200-fthm. level. The

<sup>1</sup> 'The West of England Mining Region,' *Trans. Roy. Geol. Soc. Cornwall*, vol. xiv, 1912, p. 205.

North Lode underlies south at 30° and at the 225-fthm. level joins the Middle Lode. It is patchy and carries much quartz and capel.

The vertical distribution of copper-ores in this mine was well marked, the copper-ores were mainly in the killas country, while the tin-ores came in at about 110 fthms. below adit-level.

It has been observed that in the mines of this neighbourhood the lodes underlying to the south do not carry so much sulphide ore as those which underlie in the opposite direction. Mineral pitch occurs in several of the lodes.

The average output during recent years is from 12 to 15 tons per annum of 10 to 14 per cent. ore.

For the period 1832-1905 upwards of 146,000 tons of copper-ores were sold at mines belonging to this sett.

### TINCROFT MINE, ILLOGAN.

(*Idle.*)

Shafts at Penhellick near Carn Brea station, a third of a mile south of Pool.

*Maps*.—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.W.

The country-rock consists of killas overlying granite. Henwood and others have recorded that in one part of the mine the killas underlies granite, a position possibly due to a reversed fault.

There are three lodes, two underlying to the south and one to the north. The Barncoose, North or Old Tincroft Lode underlies north and varies in width from 3 ft. in the upper levels to as much as 10 ft. below the 100-fthm. level. There are twelve levels below the adit, which lies at 26 fthms. beneath the surface. The gangue is quartzose. The South Lode underlies south at 75°, but between the 90- and the 110-fthm. it unites with the Old Tincroft Lode. It was worked below the 208-fthm. level, but carried low values for copper.

Pryce's Lode also underlies south and from the 170-fthm. level enters the property belonging to the adjoining South Crofty Mine. It carries complex sulphide ores.

All the lodes formerly contained copper pyrites (chalcopyrite) and chalcocite in their upper parts. At present the lodes carry about 8 per cent. of copper in some sections of the mine. The higher grade ore was picked out by hand, leaving from 3 to 4 per cent. of copper in the complex ore to be treated with the ores of tin and wolfram, but this is lost in the sulphuric-acid tanks. The copper-ore is found in patches, more particularly between the 60-fthm. and the 140-fthm. levels and mainly in the killas. In Cornwall copper-ores do not usually persist downwards into the granite, but in the North Tincroft Lode they form rich ground to a depth of 40 fthms. in that rock. Tincroft formerly obtained



large quantities of copper-ore from the upper workings, but these levels, on being reworked, have yielded very little copper-ore although many thousands of tons of veinstuff have been milled. The richest copper lies in the complex ore and it has been observed in this mine that where fluorspar comes in the values decrease; and also that both fluorspar and wolfram die out in depth with the copper-ores.

Many other ores of copper have been noted by Henwood, Garby and others, including condurrite or pitch copper, chrysocolla, in part replacing felspar of the granite country-rock, and purple and indigo-copper. Native copper formed a vein from one-eighth of an inch to two inches wide in the old Wheal Druid Lode and has also occurred sporadically in the other lodes.

Between 1815 and 1895 Tincroft and Carn Brea had a total output of copper-ore amounting to upwards of 350,000 tons, containing 24,000 tons of metallic copper. The output of copper-ore during recent years has averaged about 50 tons per annum.

The reserves are regarded as small as the mine is largely worked out in the copper-bearing zone.

#### THE BASSET AND NEIGHBOURING MINES, ILLOGAN (MAINLY).

*(Active in part.)*

The Basset Mines, with Tolcarne, Condurrow and Grenville United, form a group which worked principally on the Great Flat Lode. This lode consists mainly of tin-ore, but other lodes rich in copper-ores and usually with a northerly underlie produced great quantities of copper-ores. Only two mines were active in 1919 and neither raised any copper, except occasionally.

*Maps* :—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 S.W. and 63 S.E.

Most of the mines are situated on a strip of intensely metamorphosed killas lying between the two granite-masses of Carn Menellis and Carn Brea. From south-west to north-east they extend in the following order :—South Tolcarne, Great Condurrow, South Condurrow, Wheal Grenville, West Wheal Frances, West Basset, South Wheal Basset, Wheal Basset, Wheal Buller and Wheal Beauchamp.

The Basset Mines, Ltd., include Wheal Basset, West Wheal Basset and South Wheal Frances.

The Great cross-course shifts all the lodes west of Wheal Frances to the north-west.

At Wheal Basset there are many lodes, including the Great Flat Lode, which has been worked on down to the 260-fthm. level. The Great Lode underlies north and varies in width from 2 to 7 ft. Geisler's, Paddon's and the North Lodes also underlie

north and contain copper-ores. Theaker's, Vivian's, and William's Lodes underlie south, while the Caunter Lode is nearly vertical. In width the lodes vary from 1 to 12 ft.

In the West Basset sett the copper lode was rich down to the 100-fthm. level. All the lodes had good gossans, but those on the south of the mine were not so rich as the lodes on the north although they yielded both tin- and copper-ores. The Main or North Lode was not rich in copper-ore eastwards.

At Wheal Beauchamp there are five lodes. The most northerly underlies north and was worked for copper-ore. Tin- and copper-ores were found in the second, while the next two yielded only copper-ore. The southernmost yielded ores of tin but not of copper. All these lodes underlie to the north.

At Buller and Beauchamp the South Lode bears E.  $25^{\circ}$  N., underlies  $15^{\circ}$  to  $30^{\circ}$  N. and varies in width from 1 to 2 ft. It contains black copper-ore with quartz, feldspar and brown iron ore. The North Lode bears E.  $25^{\circ}$  N., underlies N.  $10^{\circ}$  to  $30^{\circ}$ , and yielded black and vitreous copper-ores down to the 50-fthm. level. Davey's Lode bears E.  $27^{\circ}$  N., underlies  $45^{\circ}$  N. or is vertical and varies from 1 to 20 ft. in width. It contained carbonates and arseniate of copper, black oxide of copper, chalcocite and copper pyrites with quartz, slate, chlorite and fluorspar.

The Great Flat Lode was the principal lode worked in the South Condurrow Mine, but only tin-ore was obtained from it. The Middle Lode, however, produced ores of both tin and copper. It underlies north but is nearly vertical and from 2 to 3 ft. wide. South of it lies the West Basset Copper Lode, from 3 to 4 ft. in width, which yielded at the 20-fthm. level the sulphides of copper in a veinstone of quartz, peach and killas. At 120 fthms. west of the Grenville shaft the Copper Lode heaves the Flat Lode 10 fthms.

The South Wheal Frances sett is traversed by five lodes bearing about E.  $35^{\circ}$  N. The North or Main Lode underlies N.  $12^{\circ}$  from the surface to the adit-level (32 fthms.); at  $10^{\circ}$  N. to the 50-fthm. and below that level at  $5^{\circ}$  N. There was a good gossan and copper-ore down to the 40-fthm. level, below which the lode was mainly tin-bearing. In width it varies from 2 to 12 ft. There are three other copper-bearing lodes, the St. Aubyn Lode, the South Lode which underlies south and is about 2 ft. wide, and Little's Lode, in addition to the Great Flat Lode which did not carry copper-ore.

The Grenville United Mines raised copper-ore in small quantities. The Copper Lode dips north and contains chalcopyrite down to the 70-fthm. level. There are several other lodes where only tin-ore occurs. The country-rock consists of killas down to about 50 fthms. with granite underlying it and rising to the surface both to the north and south.

The output from these mines is incompletely known, as no reliable records were kept before 1815 and only defective ones later:—

Mines.	Copper-ore.	Metallic Copper in the ore.	Periods.
	Tons.	Tons.	
South Tolcarne -	1,300	114	1859-1883
Great Condurrow -	30,200	2,020	1845-1876
South Condurrow -	1,060	106	1864-1902
S. Wheal Frances -	66,590	5,660	1845-1895
Wheal Basset -	94,200	8,100	1815-27, 1832-36, 1851-1905
E. Wheal Basset -	15,050	1,520	1826-32, 1845-78
North Basset -	27,800	2,200	1846-1866
South Basset -	37,100	3,020	1833-36, 1838, } 1845-61. }
S. Buller & Beauchamp	127,796	8,554	1821-1856
Buller & Beauchamp -	41,700	2,600	1823-28, 1832- } 36 and in 1838. }
Wheal Buller -	98,700	14,340	1845-1875
Wheal Grenville -	2,330	190	1860-1905
West Basset -	101,500	7,155	1852-1890

### PEEVOR UNITED MINES, REDRUTH.

(Active.)

Shafts at North Downs, one and a half miles north-north-east of Redruth.

*Maps*:—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 56 S.E. and 57 S.E.

There are several mines in the sett, the principal being Wheal Peevor, Great North Downs, North Downs, Wheal Briggan, Wheal Plenty and Wheal Boys.

Great North Downs and North Downs formerly produced large amounts of copper-ore, but in recent years only a few tons have been raised.

The country-rock consists of slate overlying granite. There are many lodes traversing the sett, which is divided by the Great cross-course. This throws down on the east the copper-bearing ground of North Downs against the tin-bearing country at Wheal Peevor.

The principal lode is the Main Lode, which bears E. 14° N., underlies S. 8° to 20° and consists of copper and iron pyrites with limonite, blende and granular quartz. The Tenpenny Lode bears E. 30° N., is nearly vertical and about 2 ft. wide. It contains copper and iron pyrites, quartz, and earthy iron-ores.

The Caunter Lode bears E. 28° N., underlies N. 7° to 10°, and varies in width from 1 to 2 ft. It consists of copper and iron pyrites with earthy iron-ore and slaty clay.



The mines have not been worked below the 110-fthm. level below adit (50 fthms.).

The output between the years 1808-1870 amounted to 40,464 tons of copper-ore. From 1792 to 1799 there is no record of tonnage, but the value of copper-ore sold slightly exceeded £360,600.

#### THE POLDICE MINES, GWENNAP.

(Active.)

This group of mines includes Poldice, West Poldice, Wheal Gorland, Wheal Jewell, Wheal Quick, Wheal Unity, Creegbrawse and Wheals Maid and Damsel.<sup>1</sup>

*Maps* :—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.E. and 64 N.W. and N.E.

The country-rock of most of the mines consists of metamorphosed slate, but at Wheal Gorland the granite rises to the surface.

In 1864 some of these mines were combined as the St. Day United Mines and afterwards again as the Poldice Mines. West Poldice was (in 1918) restarting.

In 1870 the mines were 200 fthms. deep and since then no further deepening has taken place.

At Poldice the Great Ore, Quick's, Kitty Billing's, Garby's and Holman's Lodes all contained copper-ores. The lodes all underlie to the north and are in places nearly vertical.

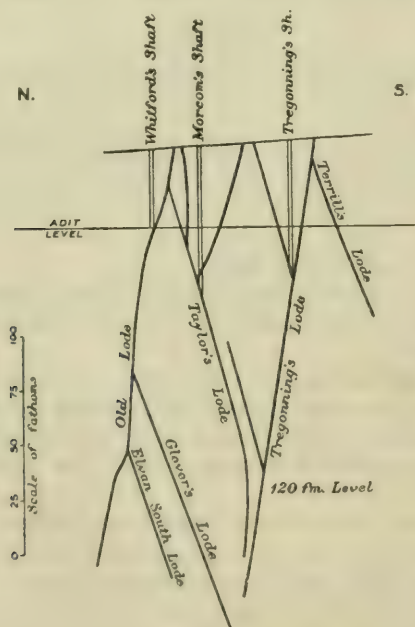


FIG. 6. Consolidated Mine.

<sup>1</sup> J. H. Collins, 'Observations on the West of England Mining Region,' 1912, p. 555.

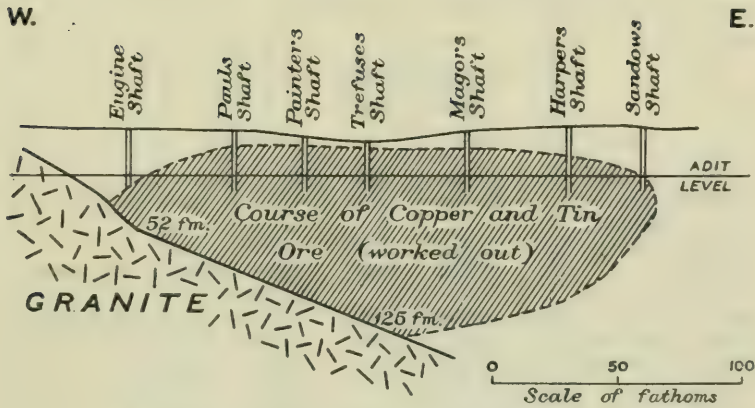


FIG. 7. West Poldice Mine, Unity Wood.

At West Poldice or Unity Wood Mine (Fig. 7) there are three lodes containing copper-ores. Pits and Vollar Lode bears E.  $30^{\circ}$  N. underlies N.  $16^{\circ}$  to  $30^{\circ}$ , and varies from  $\frac{1}{2}$  ft. to 3 ft. in thickness. The Little Ore Lode is  $\frac{1}{2}$  ft. thick, bears E.  $30^{\circ}$  N., and underlies N.  $30^{\circ}$  to  $38^{\circ}$ . The Trefusis Lode ranges from  $\frac{1}{2}$  ft. to 8 ft. in thickness, bears E.  $25^{\circ}$  N. and underlies N.  $8^{\circ}$  to  $24^{\circ}$ .

The Wheal Unity Lodes include the North and the South, Trefusis, Peter's, and Cain's north and south lodes, all of which underlie north at angles varying from  $10^{\circ}$  to  $37^{\circ}$ ; and the Frances Lode and Barrett's Lode which underlie south at  $10^{\circ}$  to  $15^{\circ}$ .

At Wheal Jewell there are four copper-bearing lodes. The Main Lode bears E.  $20^{\circ}$  N., underlies  $10^{\circ}$  to  $23^{\circ}$  N., and varies from 1 to 4 ft. in thickness. Row's Lode underlies N.  $16^{\circ}$  to  $20^{\circ}$  and is from ten to eighteen ins. thick. The Middle and the South Lodes both underlie north at  $23^{\circ}$ .

There are six lodes carrying copper-ores at Wheal Gorland, all underlying north, except Dennis Lode, which is vertical. Carne<sup>1</sup> states that the principal lode of Wheal Gorland has been traced for two miles and passes through Wheal Unity and Creegbrowse. The gossan at this mine was found to contain gold. There was also a great quantity of fluorspar worked.

At Wheals Damsel and West Damsel there are seven lodes, all underlying north and yielding copper-ores. The Main Lode has been traced for over two miles. The other lodes are the Pressure-Engine Lode, the Old North Lode, the Old South Lode, Gilbert's Lode, Turtle's Lode and the Wheal Hope Lode.

<sup>1</sup> 'On the Veins of Cornwall,' *Trans. Roy. Geol. Soc. Cornwall*, vol. ii, 1882.

The following figures show the output in tons of copper-ores during the periods 1815 to 1836, and 1845 to 1905, with the quantity of metallic copper contained in the ores :—

	Copper Ore.	Metallic Copper.	
Poldice ... ..	15,300	965	1838, 1845 to 1873.
Unity Wood... ..	21,620	1,290	1815 to 1836, 1838, and since 1853.
Unity and Poldice ...	83,100	6,890	1815 to 1832.
Gorland ... ..	38,500	2,850	1815 to 1836, 1838, 1845 and 1878.
Jewell and Quick ...	58,160	5,222	Sold between 1815 and 1853.
West Wheal Jewell...	12,578	858	1831 to 1852.
Maid and Carharrack	27,800	2,015	1821 to 1836, 1845 to 1852.
Creegbrawse and Penkevil ... ..	14,530	875	1815 and 1832, 1845 and 1902.
Damsel, Wheal	37,600	3,300	1815 to 1836, 1838, 1845 to 1872.
West Damsel, Wheal	29,150	1,560	1852 to 1874.

### TRESAVEAN MINE, GWENNAP AND REDRUTH.

(Active.)

Shafts near Lanner,  $2\frac{1}{3}$  miles south-east of Redruth station (G.W.R.).

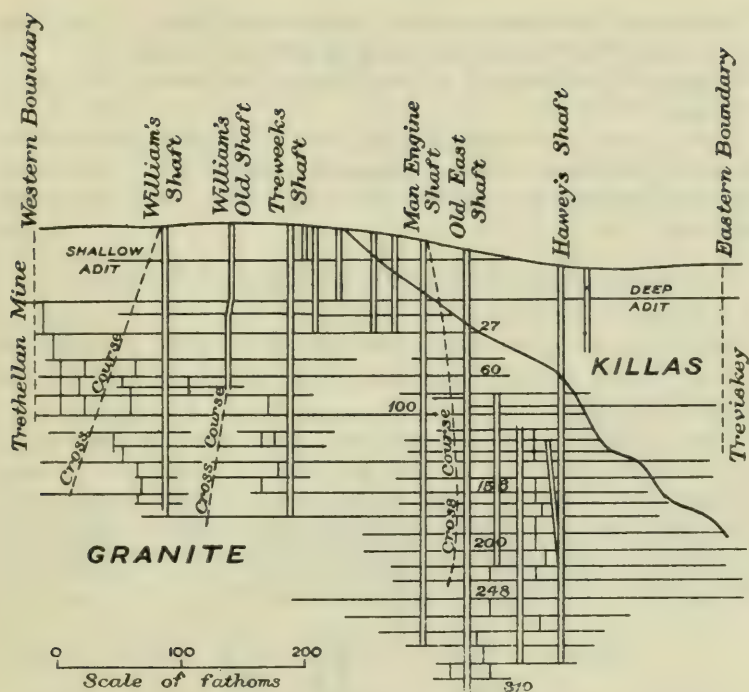
*Maps* :—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.E. and S.E.

The following mines are included in this sett :—Tresavean, Comford, Belvean, Trethellan, Tretharrup, Brewer and Treviskey, (Fig. 8).

In this group of mines there are two series of lodes, one underlying south and comprising the Magors, the Main, Michell's, Caddy's, the Copper, the Bell and the Penstruthal Lodes, while the second series consisting of the Comford, Captain Dick Williams, the Gobban, the South and Parkin's Lodes underlies generally to the north. They all carry some copper-ore, but the richest in order of importance are the Main (working), the Copper, the Bell, and the Penstruthal Lodes.

The Main Lode bears E.  $30^{\circ}$  N., underlies S. to nearly vertical and varies in width from 1 to 10 ft., being widest at the 206-fthm. level; it is usually about 4 to 5 ft. wide, while the stoping width averages 6 ft. The lode is almost confined to the granite and dies out in the killas. Its gangue consists of quartz with schorl and carries chalcopyrite in addition to other ores of copper, also blende and iron pyrites. The copper-ores extend to a depth of 286 fthms. below adit (27 fthms.), where cassiterite comes in. From the 286-fthm. down to the 345-fthm. the copper-ores diminish in quantity and below that level practically die out.



FIG. 8. *Tresavean Mine.*

The rich copper zone is upwards of 2,000 ft. in thickness throughout the mine and always occurs in granite; on reaching the killas it quickly deteriorates and is not worth working. Caddy's Lode never carried much copper-ore and is worked only to 80 fthms. below adit; it is rich in zinc blende and mispickel and there is some cassiterite. The gangue is quartzose and carries some blende. The Comford Lode contains fair values of copper-ore, but is not working. The average yield from the mine is about 5 per cent. of concentrate, of which 9 per cent. consists of metallic copper.

The output of the individual mines comprising the present sett is imperfectly known and the following figures are probably much below the total.

Treviskey Mine, after 1848 worked with Tresavean Barrier as East Tresavean Mine, 17,790 tons of copper-ore between 1845 and 1855.

Trethellan and West Trethellan were worked down to 170 fthms. from the surface, the output from 1837 to 1856 being 35,545 tons of copper-ore.<sup>1</sup>

Comford and North Tresavean had an output between 1844 and 1856 of 16,860 tons of copper-ore.<sup>2</sup>

<sup>1</sup> J. H. Collins, 'Observations on the West of England Mining Region,' 1912, p. 454.

<sup>2</sup> *Op. cit.*, p. 596.

Penstruthal and Penstruthal Consols from 1825 to 1836 and from 1845 to 1879 had an output of 59,500 tons of ore.

Tresavean sold 168,387 tons of copper-ore between the years 1815 and 1870.<sup>1</sup>

During recent years the output of metallic copper has averaged 110 tons per annum. The copper-ore output for 1915, 1916, and 1917 amounted respectively to 241 tons, 448½ tons, and 402½ tons.

#### THE CLIFFORD AMALGAMATED MINES, GWENNAP.

(Idle.)

This large group of mines lies immediately to the east of the Carn Marth granite mass and south-east of St. Day, in the parish of Gwennap.

*Maps*:—One-inch New Series Ordnance and Geological, 352: Six-inch Cornwall, 63 N.E. and 64 N.W.

There were formerly two large groups known respectively as the United Mines and the Great Consolidated Mines (Figs. 6, 9). In 1861 these were combined with Wheal Clifford under the title of the Clifford Amalgamated Mines (Fig. 10).

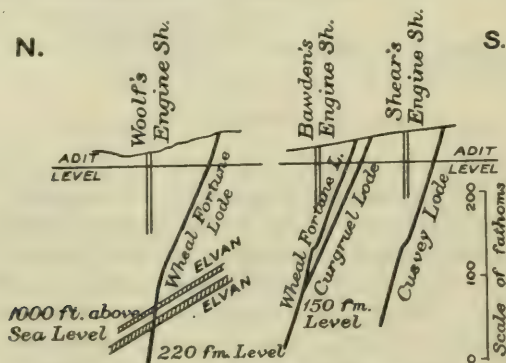


FIG. 9. Consolidated Mines.

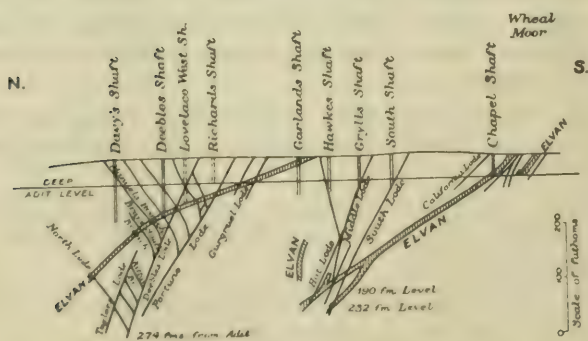


FIG. 10. Clifford Amalgamated Mines.

<sup>1</sup> J. H. Collins, 'Observations on the West of England Mining Region,' 1912, p. 598.

The United Mines included Wheal Beauchamp, Trevarth, Ting Tang, Wheal Squire, Poldory, Ale and Cakes, East Ale and Cakes and Wheal Friendship. Under the Consolidated Mines were Wheal Fortune, West Wheal Virgin, East Wheal Virgin, Carharrack, Lovelace and Cusvoe or Cusvea.

The ground worked by these mines covered an area of about two square miles and was some of the richest copper-bearing country in the world. Since reliable records have been kept the output from this area has been upwards of a million tons of copper-ore. The whole district was drained down to depths varying from 40 to 80 fthms. below the surface by the Great County adit, which with its branches extended for a length of 30 miles.

Slaty killas, in part metamorphosed by the granite, forms most of the country-rock, through which many lodes course in a general eastward direction.

Taylor's Lode was the principal one worked by the Consolidated group. This was first opened up at Wheal Virgin and has been worked on almost continuously for a distance of four miles, at Wheal Fortune, Wheal Lovelace, West Wheal Virgin and Wheal Wentworth. It courses generally  $30^{\circ}$  south of west and underlies north at  $60^{\circ}$  to  $80^{\circ}$ , but is locally vertical.

It had a good gossan, which extended often to a depth of 150 fthms. and was succeeded by a zone where great masses of the oxides of copper were found, gradually merging downwards into chalcopyrite and pyrites in a quartzose gangue. At Wheal Fortune and elsewhere considerable quantities of blende also were mined. The famous shoot of ore at Wheal Virgin consisted of a mass ranging from 12 to 30 ft. in width, of brecciated chalcopyrite, pyrites and quartz, with a pyritic cement. It was 25 fthms. long and continued downwards from the 150- to the 190-fthm. level, below which it narrowed and finally died out. In other parts the lode consisted of pure chalcopyrite, a foot thick, enclosed in a solid mass of mixed copper and iron pyrites from 6 to 12 ft. wide. The lode widened out to 30 ft. in the soft slate at Wheal Virgin, but where it traversed either the granite or elvan dykes it became narrow.

At Wheal Virgin the lode was worked down to a little below the 290-fthm. level, and at Wheal Fortune to a depth of 140 fthms. below the adit.

Other lodes worked in the sett included Paul's Lode, which was rich in black and vitreous copper-ores and copper pyrites, Glover's Lode with similar ores, and Deeble's, Wheal Fortune and the Cusvey Lodes.

In the United Mines the Great Lode was traced for a distance of nearly four miles from Wheal Beauchamp through the granite of Carn Marth into the killas at Trevarth and on through Ting Tang, Wheal Squire, Poldory, Ale and Cakes, East Ale and Cakes,



to Wheal Friendship. It courses generally a few degrees north of east and underlies at about  $75^{\circ}$  N. In Wheal Squire there are eight other lodes, all underlying north.

At Ting Tang the lode ranges from  $3\frac{1}{2}$  to 8 ft. in width and is in killas down to the 100-fthm. level. The ores consisted of oxides and sulphides of copper mingled with iron pyrites and gossan. Chalcocite chalcopyrite, melaconite, cuprite, malachite and chessylite were all worked, while at one place a vein, 2 ft. wide, of solid chalcocite extended for a distance of twenty feet.

In Poldory and Ale and Cakes the lode courses  $27^{\circ}$  N. of E. and averages 6 ft. in width. In these mines the richest copper-ground lay in the upper levels, extending downwards in places to 212 fthms. below adit-level. A good deal of barytes was associated with the copper-ores in the deeper workings.

There are many other lodes traversing this sett, of which the principal ones are the Great South, Gellard's North and South and the Mundic Lodes.

At Ting Tang Mine, in addition to the Main Lode, the Middle and Roche's Lodes both yielded large quantities of copper-ores, including the black and the red crystallised oxides and the vitreous ore. They both underlie to the north and course in a general eastward direction.

No accurate returns of output previous to 1815 are available and after that date the returns are imperfect. The following figures represent, therefore, only a part of the total yield from the mines, but these indicate the abnormal richness of the lodes in copper-ores. On reaching the usual poor zone lying elsewhere between the copper- and the tin-bearing country the mines were abandoned, but it has always been regarded as probable that beneath these levels there lies an unexploited region of tin-ore.

Mines.	Copper Ore.	Metallic Copper in the Ore.	Periods.
	Tons.	Tons.	
Clifford Amalgamated	144,300	9,140	1833 to 1836; 1845 to 1876.
Clifford, Wheal ...	9,495	725	1835 to 1856.
Clifford, Wheal ...	135,400	8,480	1857 to 1872.
Consolidated Mines...	442,493	37,461	1819 to 1858.
Squire, Wheal ...	20,000	1,506	1817 to 1825; 1852-1853.
United Mines ...	304,530	22,680	1815 to 1856.
United Mines ...	43,110	2,063	1857 to 1861.
Virgin, Wheal ...	22,974	1,656	(Sold.) 1821 to 1847.
West Wheal Squire...	3,390	383	1818 to 1822.

It is impossible to estimate the reserves of copper-ore, but there are tracts where some ore may be expected; these reserves would form a useful asset if the group of mines were worked for tin-ore.

## TING TANG MINE, GWENNAP.

(Idle.)

Shafts situated a little to the South of Carharrack and two miles east-south-east of Redruth.

*Maps*:—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 63 N.E.

The country-rock consists of metamorphosed slate.

There are five lodes in the mine. According to Henwood<sup>1</sup> the Main Lode courses E. 12° N., underlies N. 8° to 30° and contained copper pyrites, earthy brown iron-ore, and black and vitreous copper-ore. At the 80-fthm. level there was some chrysocolla with black copper-ore and copper pyrites and at the 90-fthm. some oxide of copper. The blue and the green carbonates associated with quartz and chlorite occurred at the 140-fthm. level. The Middle Lode courses E. 21° N., underlies N. 4° to 22° and varies in width from one to four feet. At the 90-fthm. level the lode contained vitreous and black copper-ore and crystallised red oxide of copper, and at the 140-fthm. level, vitreous copper, chlorite and granular quartz. Roche's Lode courses E. 8° S., underlies N. 10° to 22° and varies in width from one and a half to three ft. It contained copper pyrites and vitreous and black copper-ore from the 90- to the 120-fthm. level.

Thomas states that there is a Flat Lode in this mine which yielded both copper- and tin-ores. It is the continuation of the Wheal Lovely and Wheal Squire Lode and underlies N. 45°. Seven fthms. south of the Flat Lode is the Mundic Lode, which underlies N. 45°.

Between 1816 and 1835, 38,124 tons of ore, containing 3,235 tons of copper, were sold by public ticketing, and 841 tons containing 50 tons of copper between 1845 and 1847.<sup>2</sup>

## GREAT WHEAL BUSY (THE OLD CHACEWATER MINE), KENWYN.

(Idle.)

The shafts are situated about four-fifths of a mile north-north-east of St. Day Church.

*Maps*:—One-inch New Series Ordnance and Geological, 352 : Six-inch Cornwall, 57 S.W.

This is one of the oldest copper mines in Cornwall, and forms one of a group of mines comprising Wheal Daniell, Wheal Ann, Killifreth and Hallenbeagle or Halbeagle. This group, with some other mines situated in the parishes of Kenwyn, Kea, Redruth and St. Agnes, forms an assemblage which might be termed the "Mines of the North Downs." They cover an area of about three square miles and have never been completely explored, their

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table LX.

<sup>2</sup> 'The Geology of Falmouth and Camborne,' (*Mem. Geol. Surv.*), 1906, pp. 243-244.

average depth being a little less than 150 fthms. Through this area there are many lodes coursing generally E.N.E. which are heaved by some cross-courses running approximately north-west. Of many of the mines but little more than name and site are known and of some others only imperfect records of output and a few particulars relating to the course, underlie and width of the lodes; it seems desirable, therefore, to give only a tabular statement embracing such facts as are known.

Name of Mine.	Lodes.	Underlie, Width, etc.	Output of Copper Ore in Tons.	Periods.
Wheal Chance...	—	183 fathoms deep	14,800	1815-1828.
North Treskerby	—	—	19,270	1859-1882.
Treskerby ...	North	N. 10° ...	—	—
" "	Chacewater or Williams.	N. 40° to 50 fathoms then N. 27°.	—	—
" "	Williams	N. 28°.	—	—
" "	South.	—	—	—
" "	Teague's	S. 23°.	—	—
" "	Flat	N. 40° ...	32,510	1815-1832.
" "	Carquagen	N. 5° to 15° ...	18,500	1823-1827.
" "	North and South.	—	—	—
Wheal Boys ...	Wheal Boys	S. 15° ...	22	—
Wheal Derrick	N. Carquagen	N. 27°.	—	—
" "	3 others	North.	—	—
Cardrew ...	South	N. 10°-30°, bears E. 17° N. $\frac{1}{2}$ to 6' thick.	—	—
" ...	North	S. 8°-22°, bears E. 17° N. $\frac{2}{3}$ -2 $\frac{1}{2}$ ' thick.	17,143	1826-1838.
Wheal Harmony or Treleigh Wood.	Wheal Bray	N. 13° ...	22,450	1820-1834 1845-1880.
Wheal Hawke...	Tenpenny	S. 13° ...	—	—
" ...	Pendarves	N. 23°.	—	—
" ...	Wheal Hawke	S. 23°.	—	—
Wheal Rose ...	—	160 fathoms deep...	12,820	1862-1872.
Treleigh Consols	Good Success and North	N. 23° ...	21,900	1838-1855.
Daniell, Wheal	Good Success. William's	S. 32°.	—	—

At Hallenbeagle or Halbeagle there are four lodes. The Hallenbeagle Lode underlies S. 15° and is recognised in Wheals Rose, Hawke and Messar. Its principal ore is copper pyrites. The South Lode, also copper-bearing, underlies S. 13°. Raby's Lode underlies N. 13°, and William's Lode, S. 23°, both carrying copper-ores.

Between 1835 and 1846, 30,576 tons of ore containing 1,803 tons of copper were sold by public ticketing.<sup>1</sup> The mine is worked to the 70-fthm. level.

<sup>1</sup> Phillips and Darlington, 'Records of Mining and Metallurgy,' 1857.



Of the Wheal Busy or Chacewater Mine some more details are known.

William's Lode underlies S. 15° and passes eastwards into Wheal Daniell and westwards into Wheal Chance. It is the South Lode of Wheal Chance, Treskerby and Wheal Boys and Wheal Prussia. Chacewater Lode carries copper-ores and underlies N. at 47°. It is known in Wheal Daniell, Treskerby and Cardrew. Winter's Lode underlies N. 47° and carries copper-ore. Wheal Vor Lode underlies N. 22° and has yielded much copper-ore. The quantity of copper-ore sold between 1815 and 1822 amounted to 30,140 tons, and between 1823 and 1856 to 33,486 tons containing 1,669 tons of metallic copper. The total recorded output is 92,100 tons of ore containing 4,600 tons of metallic copper.

During recent years a few tons of copper-ore have been sold.

Further west lie the Tolgus mines. There is hardly any published information relating to this group. South Tolgus was worked down to the 157-fthm. level below adit (30 fthms.); West Tolgus to the 135-fthm. level; and Great South Tolgus to the 80-fthm. level below adit. These mines are now owned by the Tehidy Minerals Company.

The output of copper-ore was as follows :—

—	Tons of Ore.	Tons of Metallic Copper.	Period.
East Wheal Tolgus...	17,140	1,260	From 1847 to 1863.
Great South Tolgus	16,500	1,100	„ 1854 to 1869.
South Tolgus ...	36,770	2,850	„ 1848 to 1865.
Wheal Tolgus ...	30,750	2,855	„ 1825 to 1836, 1838.
West Tolgus... ..	47,700	4,020	„ 1832 to 1836; from 1861 to 1883.

List of mines, not included in the foregoing pages, with total outputs of copper-ore exceeding 2,000 tons.

Name of Mine.	Parish.	Six-inch Map, Cornwall.	Output in Tons.	Period.
Wheal Buckets...	Redruth	63 N.E.	2,700	Between— 1846 and 1849.
Camborne Vean	Camborne	63 S.W.	37,500	1816 and 1832, and between 1845 and 1855.
Carn Brea, East	Redruth	63 N.E.	22,080	Since 1859.
Carn Camborne...	Camborne	63 S.W.	6,310	Between— 1862 and 1879.
Carvannel ...	Gwennap	63 S.E.	2,500	1851 and 1856.

Name of Mine.	Parish.	Six-inch Map, Cornwall.	Output in Tons.	Period.
Chance Consols...	Gwennap and Redruth	56 S.E.	3,998	Between— 1826 and 1827.
Wheal Clowance	Crowan	69 N.E.	7,580	1815 and 1824.
Clyjah and Went- worth.	Redruth	63 N.E.	2,500	1854 and 1862.
Wheal Courtis ...	Crowan	69 S.E.	2,290	1864 and 1869; and in 1838.
Crenver, Abraham and Oatfield.	Crowan	69 S.E.	112,050	1815 and 1832, 1845 and 1870.
Ellen United ...	Illogan and St. Agnes	56 S.E.	12,600	1834 and 1836, in 1838, 1845 to 1865.
Wheal Fanny ...	Illogan	63 N.W.	8,450	1815 and 1822.
Grambler and St. Aubyn.	Gwennap	63 N.E.	8,440	1845 to 1868.
Great Wheal Vor	Breage	75 N.E.	2,270	1822 and 1826, 1832 and 1836, and in 1838.
Wheal Hope ...	Kea and Gwennap	64 N.W.	4,910	1826 and 1832, 1845 and 1866.
Wheal Lydia ...	Illogan	56 N.E.	3,900	1845 and 1847.
Wheal Maria ...	Redruth	56 S.E.	41,150	1845 and 1847.
Wheal Mary ...	Redruth	56 S.E.	7,670	1827 and 1836, 1845 and 1872.
„ „ Con- sols.	„	„	2,370	1830 and 1832, 1845 and 1849.
Wheal Music ...	St. Agnes	56 S.E.	4,600	1815 and 1825, and in 1832 and 1833.
Nangiles and Wheal Andrew	Kea	64 N.W.	3,020	1845 and 1876, and in 1905.
North Pool ...	Illogan	63 N.W.	47,670	1845 and 1867.
North Wheal Grambler	Redruth	63 N.E. ?	2,670	1859 and 1867.
Perseverance (and Wentworth and Copper Hill)	Redruth	63 N.E., 63 S.E.	10,870	1856 and 1877.
Prosper United	Kenwyn	64 N.W.	22,490	1863 and 1872.
Wheal Rose ...	St. Agnes	56 S.E.	12,820	1862 and 1872.
South Carn Brea	Illogan	63 N.E.	3,550	1856 and 1877.
South Wheal Ellen	St. Agnes	56 S.E.	2,600	1856 and 1861.
South Towan ...	St. Agnes	56 N.E.	12,900	1819 and 1827, 1832 and 1836, and in 1838.
Wheal Sperries...	Kea	64 N.W.	2,275	1830 and 1832, 1845 and 1855.
Wheal Spinster...	Gwennap	63 N.E.	4,500	1815 and 1829.
Tolcarne ...	Gwennap	63 N.E.	5,630	1860 and 1870.
Wheal Trannack	Sithney	76 N.W.	8,200	1832 and 1835, and in 1822, and in 1864.
Trevoole... ..	Crowan	70 N.W.	3,400	In 1827 and from 1859 to 1862.
United Hills ...	St. Agnes	56 N.E.	26,110	From 1822 to 1836, and 1845 to 1847.

Name of Mine.	Parish.	Six-inch Map, Cornwall.	Output in Tons.	Period.
Wheal Uny ...	Redruth	63 N.E.	2,860	Between 1853 and 1893.
Wheal Vyvian ...	Constantine	77 N.W.	4,140	From 1832 to 1836, in 1838, and between 1845 and 1864.
Wheal Wellington	Camborne	63 N.W.	2,830	Between— 1822 and 1827.
West Stray Park	Camborne	63 S.W.	3,635	1854 and 1868.



## CHAPTER III.

DETAILS OF THE MINES (*continued*).

## III. THE ST. AUSTELL DISTRICT.

This mining district (Plate II) lies on the south-eastern border of the St. Austell granite mass and extends from Polgooth north-eastwards for a distance of seven miles through Tywardreath to near Lanlivery, the width of the tract averaging two miles. In the southern part of this district the lodes course a little north of west or nearly east and west, but further north their direction changes to south of west. The principal mines are the Fowey Consols, the Par Consols, East Crinnis, and the Pembroke Mine.

## FOWEY CONSOLS, TYWARDREATH.

(*Idle.*)

The shafts are situated at a distance of about a mile north of Tywardreath Church.

*Maps*.:—One-inch New Series Ordnance and Geological, 347 : Six-inch Cornwall, 42 S.E.

The sett includes Lanescot, Wheal Treasure, Wheal Fortune and Wheal Chance.

The country-rock consists principally of grey slates with interbedded seams of grit and belongs to the Meadfoot division of the Lower Devonian. There are many important lodes in the sett, which were fully described by Henwood<sup>1</sup> and by De la Beche<sup>2</sup>, whose observations afford practically all the information there is concerning them. The names of the principal lodes (Fig. 11) from south to north are Bones, A branch, McKennie's, Crosspark, Sampson's, Notwell's, Cook's, Ann's, Williams's, Reed's, Trathan's, Black and Bices. Notwell's and Ann's Lodes are practically vertical, while the others underlie north at an average of about 60°. They course nearly parallel, and in a general east and west direction with the exception of Reed's Lode and Cook's Lode, which course E.S.E. and Trathan's Lode, which courses E.N.E. They outcrop within a strip 2,000 feet wide, but extend east and west for a distance of nearly 6,000 feet.

Bones Lode between the 90- and the 120-fthm. level varies in width from six inches to 3 ft., and contains quartz, slate, copper and iron pyrites, carbonate of iron and chlorite. Cook's Lode from the 35- to the 57-fthm. level varies from six inches to 2 ft. in width and consists of copper and iron pyrites in a quartz and slate gangue. Ann's Lode varies from 1 to 1½ ft. in width and contains a similar assemblage of ores. Williams's

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table LXXXIX., p. 130.

<sup>2</sup> 'Report on the Geology of Cornwall, etc.', 1839, p. 600.

Lode from the 35- to the 90-fthm. level varies from six inches to 3 ft. in width. The lode consists of vitreous and black copper-ores, copper pyrites, limonite, carbonate of iron and pyrites with quartz, while some sulphide of bismuth was found in cavities in the lode. Trathan's Lode contains copper pyrites and varies in width from six inches to  $5\frac{1}{2}$  ft.<sup>1</sup>

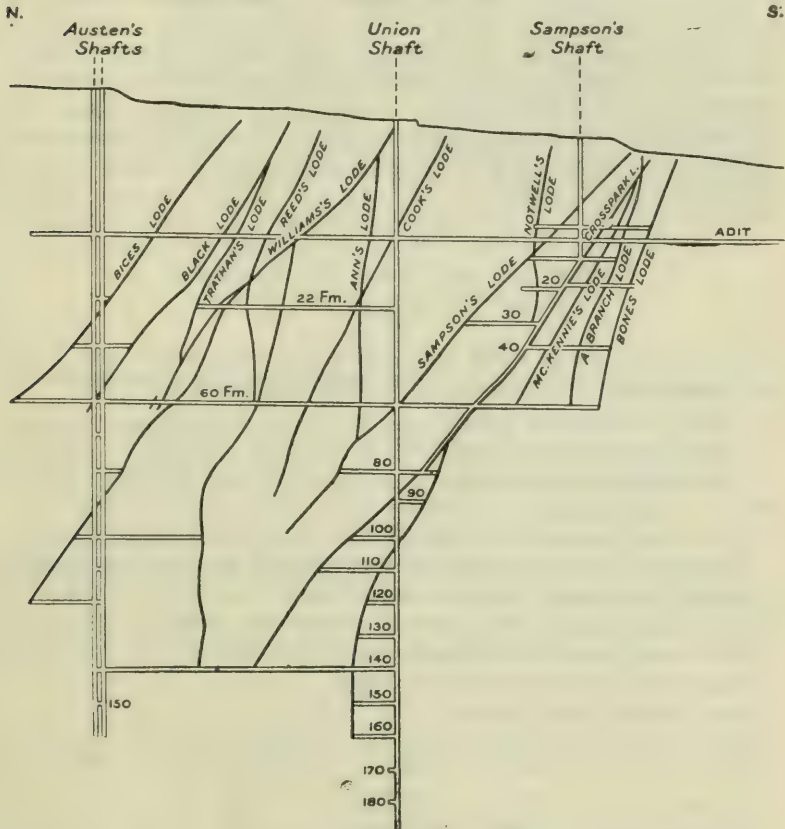


FIG. 11. Fowey Consols Mine.

De la Beche<sup>2</sup> states that the dip of the slate is towards the east and away from the granite so that "as the lode has a general east and west direction, the beds traversed by it on the lower part of the mine on the east rise to the surface on the western end, and it is found that the bunches of ore accompany this dip . . . so as to coincide with certain beds." Further on he says 'the mode in which the "gossan" and other marks of the back, or higher part, of a copper-lode dip to the eastward with the beds in this mine is extremely interesting; gossan, with its very common accompaniments of native copper, and grey

<sup>1</sup> 'The Geology of Bodmin and St. Austell,' (*Mem. Geol. Surv.*), 1909, p. 144.

<sup>2</sup> 'Rept. Geology of Cornwall, Devon and West Somerset,' 1839, pp. 335-6.

copper-ores descending, above the bunches of the common yellow bisulphuret of copper, to the depth of about 600 feet from the surface on its eastern part.' Much of the lode material consists of fragments of slate cemented by yellow copper-ore and quartz and specimens show that the fissure reopened again and again during periods of mineralisation. There is a diagrammatic figure of this veinstone in the Survey Memoir.<sup>1</sup> Ores of silver, cadmium, nickel, antimony and tin have also been recorded. The mine was worked to below 300 fthms. under adit-level (40 fthms.). The total output of copper-ores from 1822 to 1867 amounted to 319,790 tons, yielding 25,020 tons of metallic copper. Lanescot was taken over by Fowey Consols in 1836; during its independent existence its output was 63,123 tons of copper-ore, yielding 5,132 tons of metallic copper.

### PAR CONSOLS MINE, ST. BLAZEY.

(*Idle.*)

The shafts are situated on a hill west of Par Sands and about half a mile south-south-east of St. Blazey station (G.W.R.).

*Maps* :—One-inch New Series Ordnance and Geological, 347 : Six-inch Cornwall, 51 N.W.

The country-rock consists of metamorphosed Lower Devonian rocks.

This mine includes the old Mount Mine, with some others.

According to Collins<sup>2</sup> the mines reopened in 1834 but records of output are from 1841 to 1869. They were copper mines to the 250-fthm. level and tin mines below that level.

The total output of copper-ores amounted to 122,689 tons, yielding 11,205 tons of metallic copper.

### EAST CRINNIS AND SOUTH PAR, ST. BLAZEY AND ST. AUSTELL.

(*Idle.*)

Shafts near the G.W.R. main line, and two-thirds of a mile south-east of St. Blazey Gate Church.

*Maps* :—One-inch New Series Ordnance and Geological, 347 : Six-inch Cornwall, 51 N.W.

The country-rock consists of Lower Devonian slate.

According to the published cross-section of the mine there are five lodes underlying north and a slide inclining south. The lodes from south to north are the South Lode, the Iron Shaft Lode, the North Lode, George's Lode and another. Henwood gives details of the mine.<sup>3</sup> The South Lode dips south down to the 40-fthm. level; at the 50-fthm. it changes to 70°–80°

<sup>1</sup> 'The Geology of the Country around Bodmin and St. Austell,' (*Mem. Geol. Surv.*), 1909, p. 145.

<sup>2</sup> 'The West of England Mining Region', 1912, p. 543.

<sup>3</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. v, 1843, Table LXXXVIII., p. 130.



north. It maintains its northerly dip down to the 100-fthm. level, but decreases in amount to only  $40^{\circ}$ – $45^{\circ}$ . In width it varies from 2 ft. to 10 ft. The upper parts of the lode consisted of carbonate of iron, and copper and iron pyrites; vitreous and black copper-ore come in below the 50-fthm. level. The North Lode dips south from  $68^{\circ}$ – $82^{\circ}$  and varies in width from 4 ins. to  $3\frac{1}{2}$  ft. The distribution of the copper-ores resembles that of the South Lode.

De la Beche<sup>1</sup> states that fragments of the country-rock are cemented by yellow copper-ore and quotes a statement of the mine captain that this phenomenon occurred throughout all parts of the lodes. From 1820 to 1841 and from 1860 to 1862 the output of copper-ores amounted to 70,919 tons, yielding 7,344 tons of metallic copper. South Crinnis from 1849 to 1867 produced 15,854 tons of copper-ore containing 1,102 tons of copper.

#### PEMBROKE MINE, ST. BLAZEY.

(*Idle.*)

Shafts about two-thirds of a mile south of St. Blazey Gate Church.

*Maps*:—One-inch New Series Ordnance and Geological, 347: Six-inch Cornwall, 51 N.W.

The country-rock consists of Lower Devonian Beds.

The mine is divided by a cross-course, known as the 'Great Cross-course.' On its western side from south to north the lodes are the Red Lode, the Main Lode, Mitchell's Lode and the Middle Lode, all underlying north, and east of the cross-course the Pembroke Lode also with a northerly underlie.

'From the 28- to the 120-fthm. level the lode varies in width from 1 to 8 feet, and consists of quartz, clay, slate and chlorite with copper and iron pyrites vitreous and native copper, melaconite, redruthite, zinc blende, and carbonate of iron. The fluccan which traverses the lode is stated to heave it 60 fthms. to the right.'<sup>2</sup> The mine was worked to 145 fthms. below adit. The distribution of the ores of copper has been described by Richard Taylor.<sup>3</sup> Yellow ore occurred principally in the eastern part of the mine near the cliffs. In the central part the yellow ore was mixed with the grey and black copper-ores, and in the western part the grey and black ores occurred above the yellow ore. Further westwards on the same lodes the grey, black and yellow ores were found, the yellow thickly coated with the grey and black ores.

The total output of copper-ores between 1815 and 1839, and from 1862 to 1867 was 85,900 tons, and 6,665 tons of metallic copper. Pembroke and East Crinnis from 1852 to 1859 had an output of 9,133 tons of copper-ore.

<sup>1</sup> 'Report on the Geology of Cornwall, etc.,' 1839, p. 323.

<sup>2</sup> 'The Geology of Bodmin and St. Austell,' (*Mem. Geol. Surv.*), 1909, p. 149.

<sup>3</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. vi, 1846, p. 99.

## IV. THE CARADON DISTRICT.

This district (Plate II) constitutes a well-defined area of nine square miles situated on the south-east of the Bodmin Moor granite. The district is traversed from north to south by a great cross-course, and is divided by a tract of impoverished ground near Caradon Hill. To the north the lodes contain cassiterite as the principal constituent and dip south, whereas south of the hill copper-ores formed the principal filling in lodes dipping north. Henwood<sup>1</sup> gives the following account of the two groups of lodes :—

“ The *lodes*—comprehending every ingredient of the rocks they traverse, although differently aggregated and in different proportions,—consist chiefly of quartz, chlorite and felspar; associated, at intervals, with smaller proportions of mica and schorl. Sometimes the three principal of these constituents, but perhaps more frequently two of them indifferently, are intimately mixed; and, occasionally, this incorporation is veined or sprinkled with the same substances in different degrees, with either of them separately, or—in the S. of the district—with fluor.

As well N. as S. of Caradon the shallower parts of the *lodes* contain, at times, considerable quantities of earthy brown iron-ore; but it, and the minerals which accompany it, are not of precisely the same character on opposite sides of the granite.

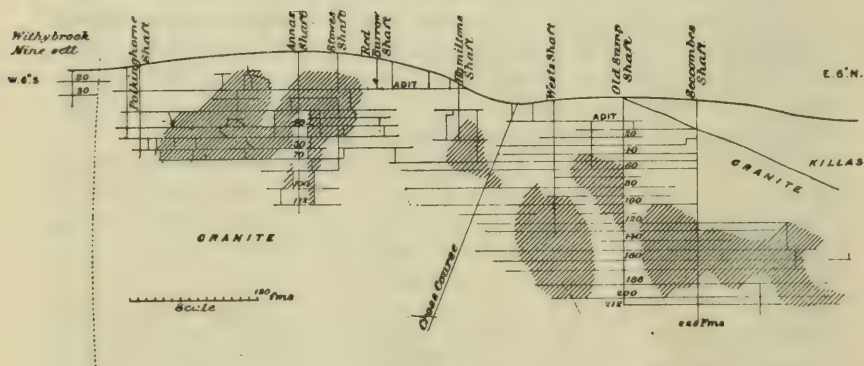


FIG. 12. *Phoenix Mines. Longitudinal section of the Main Lode.*

*Stowes, Phoenix, South Phoenix, Dunsley Phoenix, and Marke Valley* (Fig. 12)—wrought in the granite or in the slate adjoining it,—afford iron-ore of dark brown—occasionally, indeed, of blackish—hue, scattered through hard, massive, though frequently cavernous, quartz and mixed—downward especially—with chlorite. In a matrix of this character these (N.) *lodes* have—perhaps for ages—yielded an abundance of tin-ore. Softer and lighter-coloured varieties of iron-ore, mixed with granular quartz, are impregnated with earthy black copper-ore, the red oxide of copper, malachite, tamarite, chrysocolla, vitreous copper and tile ore.

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, 1871, pp. 675–680.

At *Marke Valley* the *lodes*—as they traverse the slate—cease to yield earthy iron-ore within short distances of the surface, and thenceforth consist of quartz, chlorite and felspar, mixed in various parts with different proportions of iron-pyrites, copper-pyrites, and tin-ore; sparingly, and at wide intervals, sprinkled with minute nests of earthy black copper-ore. . . . At *Phoenix*—in the granite—on the contrary, the *lode* is still charged with earthy iron-ore, as well as with native copper, earthy black copper-ore, malachite, vitreous copper, copper-pyrites, and tin-ore to the very bottom of the mine.”

“The outcrops (*backs*) of the more numerous but narrower, *lodes*, opened in the S. slope of the granite at *West Caradon* and *South Caradon* consist of soft, pale—and occasionally reddish-brown iron-ore, granular and friable quartz, granitic matter, chlorite in small quantities, and fluor at intervals. Where a cellular structure prevails nests of felspar-clay, earthy black copper-ore, and malachite are not uncommon; elsewhere the same vein-stones enclose also small shapeless *bunches* of vitreous copper, copper-pyrites, iron-pyrites and mispickel; and masses of native metal, encrusted with crystals of ruby-copper, and invested with earthy black copper-ore, are of casual, but less frequent occurrence.

In the deeper parts of both mines quartz, felspar, chlorite, and occasional masses of granite, are still the chief ingredients; but earthy brown iron-ore—although yet observable here and there—is less plentiful than it had previously been, whilst fluor—on the contrary—is much more abundant. The proportions of vitreous copper, earthy black copper-ore, and malachite decline at the same time; and ruby copper as well as the native metal—still dwindling as the depths increase—at length disappear; in copper-pyrites, however, as in fluor, the deepest parts of the *lodes* are the richest. Whether at smaller or greater depths these (S.) *lodes* give little or no tin-ore.

It appears, therefore, that the *lodes* of *Stowes*, *Phoenix*, *South Phoenix*, *Dunsley Phoenix*, and *Marke Valley* (N. of the Caradon granite) have afforded beside copper and several of its ores—large quantities of tin-ore, but contain no fluor; whilst the *lodes* of *West Caradon* and *South Caradon* (S. of the Caradon granite) have yielded copper, copper-ore, and fluor in very great abundance; but, notwithstanding the immediate vicinity of stanniferous granite at *Gonamena*, they give little or no tin-ore.”<sup>1</sup>

The principal mines of the southern group are, in order of importance, South Caradon, Marke Valley, West Caradon, East Caradon, Glasgow Caradon, Craddock Moor and Gonamena Mine. Other mines of which Wheal Phoenix was the chief, had important outputs. Small quantities of ore are still raised at the Treveddoe Mine, Warleggon and some precipitated copper is obtained from the drainage waters of the Caradon Mines at Crows Nest, St. Cleer.

<sup>1</sup> *Op. cit.*, pp. 679–680.



## WEST CARADON, ST. CLEER.

(Idle.)

The shafts are situated at about two miles west of Pensilva.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.W.

The country-rock consists entirely of granite.

There are twelve principal copper lodes, which are continuous with those in South Caradon, all of which have been productive. They are intersected at right angles by numerous cross-courses, two being important, heaving the lodes to the right from 2 to 6 fthms. The great cross-course which separates this mine from South Caradon was of importance when the mine was in work as the drivages along it met with softer ground than the hard granite.<sup>1</sup> All the lodes have a general underlie north. They produced yellow copper-ore, together with grey ore, while the gangue consisted chiefly of peach and prian. The Menadue Lode produced some large specimens of purple or peacock-ore. The veinstones comprised chalcopyrite, copper glance, erubescite, tenorite, cuprite, malachite, and native copper, with mispickel, chlorite, fluorspar, felspar and quartz.<sup>2</sup>

No. 2 Lode coursed E.N.E. and had an underlie N.N.W. of 1 in 8. Menadue Lode courses nearly parallel with this but has an underlie of 1 in 3. According to Henwood,<sup>3</sup> the lodes range in width from a few inches to 3 ft., but Jope's Lode is as much as 9 ft. wide.

The mine was worked to a depth of 187 fthms. below surface, and there were many shafts including Crouch's, Fox's, Elliott's and Pryor's.

The total output of copper-ore between 1843 and 1886 amounted to 91,700 tons which yielded 8,560 tons of copper.

## SOUTH CARADON, ST. CLEER.

(Idle.)

The shafts are situated 3,000 yards north-east of St. Cleer Church.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.W.

The country-rock consists of granite, soft and decomposed near the surface, but harder at depth.

The lodes in this sett are thrown down east by the Great Cross course which lies between the South and the West Caradon Mines. From south to north they are :—Kitto's South Lode, Kitto's North Lode and the Caunter Lode, Jope's Lode, Clymo's

<sup>1</sup> Webb and Geach, 'History of Mining in the Caradon and Liskeard District,' 1863, p. 35.

<sup>2</sup> 'The Geology of Tavistock and Launceston,' (*Mem. Geol. Surv.*), 1911, p. 104.

<sup>3</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, part 2, 1871, Table XXIII.

Lode, Pearce's Lode, Dowding's Lode, Main Lode, Menadue Lode, Webb's Lode, and Gerald's Lode. They all course from about  $5^{\circ}$  south to  $35^{\circ}$  north of east, underlie at from  $16^{\circ}$  to  $30^{\circ}$  north, and are intersected at right angles by several cross-courses. Kitto's North Lode and the Caunter Lode run parallel and close to each other and are the most productive of the district. Most of the lodes are narrow, ranging from 1 to 2 feet in width, but occasionally they open out to 4, 8 or even 10 ft.<sup>1</sup> The southern part of the mine was worked to a depth of 250 fthms. below adit, and there were several deep shafts. The more northerly lodes were tested to depths of from 40 to 80 fthms.

There was a good gossan which contained much limonite often in a cellular condition. The higher parts of the lodes carried melaconite, cuprite, malachite, chessylite and a little native copper, with quartz and kaolin. These were succeeded at depth by chalcopyrite, bornite and chalcocite, with pyrites and mispickel and considerable quantities of chlorite and fluorspar. There were frequent vughs lined with beautiful crystals of the ores of copper. Parts of the mine yielded large quantities of copper-ore averaging  $8\frac{1}{2}$  per cent. of copper.

The output between 1838 and 1885 amounted to 217,820 tons of copper-ore which yielded 21,752 tons of metallic copper.

#### CRADDOCK MOOR MINE, ST. CLEER.

(*Idle.*)

The shafts are situated  $1\frac{1}{2}$  miles north-north-east of St. Cleer Church.

*Maps*.—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.W.

The country-rock consists of granite.

There are said to be eleven lodes in the sett, their average bearing being E.  $10^{\circ}$  N. ; and five cross-courses.

Vivian's North Lode which varies from  $\frac{1}{2}$  to 4 ft. in width was poor and small from the 20- to the 32-fthm. level; at the 72-fthm. it was rich but depreciated slightly down to the 96-fthm. level. The country-rock is hard close up to this lode.

The Menadue Lode of West Caradon underlies north and enters this mine at the 70-fthm. level. Some fine purple ore was obtained from it.

Gerald's Lode lies south of Vivian's and courses parallel with it; it was not rich. Gilpin's Lode underlies north and proved rich down to the 60-fthm. level; at the 48-fthm. west of Harris's Shaft it is composed of spar, mundic and peach, with grey and yellow copper-ores.<sup>2</sup>

The output of copper-ores and metallic copper between 1856 and 1874 was 20,080 tons and 1,610 tons respectively.

<sup>1</sup> J. H. Collins, 'The West of England Mining Region,' 1912, pp. 253 and 254.

<sup>2</sup> Webb and Geach, 'History of Mining in the Caradon and Liskeard District,' 1863, pp. 12, 13.

## GONAMENA MINE, ST. CLEER.

(Idle.)

The shafts are situated about  $1\frac{2}{3}$  miles north-north-east of St. Cleer Church.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.W.

The country-rock consists of granite.

There are three principal lodes all underlying north. They are known as Sarah's or Sara's Lode, Taylor's Lode and Gilpin's Lode. They are heaved to the right by a cross-course which intersects them nearly at right angles. Henwood describes the working of a mass of stanniferous granite in an excavation about 11 acres in extent and 8 fthms. deep.<sup>1</sup>

The Sara's Lode outcrop consisted of gossan with tin-ore : from the 30- and down to the 90-fthm. level there was a good course of ore carrying tin and copper. Gilpin's Lode is one of the northern lodes of West Caradon, but it enters Gonamena at depth. On the east of the sett the lode was met with at the 20-fthm. where it was rich in yellow, grey and black ores of copper which continued down to the 114-fthm. level. It was proved productive down to the 90-fthm. Taylor's Lode also enters the sett at depth from West Caradon and contains good yellow ore. In 1863 the mine was sunk to a depth of 100-fthms. from surface.<sup>2</sup>

The total output, between 1848 and 1872, of copper-ores amounted to 9,985 tons with 685 tons of metallic copper.

## EAST CARADON, LINKINHORNE.

(Idle.)

The shafts are situated at about a mile west-north-west of Pensilva Church.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.E.

The country-rock consists of granite north of the Caunter Lode and of killas to its south.

The lodes are some of those worked at the South Caradon and Gonamena Mines which adjoin the sett on its western side. The principal lode is the Caunter which lies at the junction of the granite and killas. The lodes course about  $15^\circ$  north of east ; the Caunter underlying south and the others north.

The Caunter was driven on both at the 50- and the 60-fthm. levels close up to the western boundary. At the 50-fthm. it was very rich, at several points being worth £100 per fathom ; while

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, 1871, pp. 664-665.

<sup>2</sup> Webb and Geach, 'History of Mining in the Caradon and Liskeard District,' 1863, pp. 51-53.



in the eastern drivage it varied from £30 to £100 per fthm. At the 60-fthm. it was worth from £40 to £60 per fthm. but at the 70-fthm. it was not so good.<sup>1</sup>

The output of copper-ore, between 1860 and 1885, was 54,000 tons which yielded 3,770 tons of metallic copper. Some of the ore in 1882 yielded 3 or 4 ounces of silver per ton.

#### MARKE VALLEY, LINKINHORNE.

(*Idle.*)

The shafts are situated at about a quarter of a mile south of St. Paul's Church, Upton.

*Maps*:—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 N.E.

The country-rock consists of granite overlain by metamorphosed slate.

This, one of the oldest, was a most productive mine. The following details are derived in part from the descriptions of the mine by Henwood<sup>2</sup> and by Webb and Geach.<sup>3</sup> There are seven lodes and a cross-course; the richest being Marke's Lode, Old Sarum or Rosedown Lode, and Fisher's Lode. Lying in granite to the south there are the New Lode, South Maria Lode and another lode, while on the north-east of the sett a lode called the Cottage Lode has been worked down to the 80-fthm. level.

Marke's Lode courses a little north of east, underlies at 10° to 20° north, and was proved to be 4 ft. thick. Old Sarum or Rosedown Lode courses north of east, underlies north at 24° to 40° and varies in width from 1 ft. to 22 ft. Fisher's Lode, New Lode, South Maria Lode, which was very productive, and another lode all underlie steeply north. There is a cross-course a little west of the Old Whim Shaft which intersects the South Maria and another lode. The principal shaft, the Salisbury Shaft, was sunk down to the 100-fthm. level in 1863, and the mine was worked to below that level.

The Rosedown and Marke's Lodes both contained quartz, felspar and feldspathic clay with copper and iron pyrites, and black copper-ore. The Rosedown Lode contains some tin-ore.

The output, between 1844 and 1890, amounted to 128,500 tons of copper-ore which contained 6,585 tons of metallic copper.

#### GLASGOW CARADON (THE TOKENBURY AND YOLLAND CONSOLS), ST. IVE.

(*Idle.*)

The shafts are situated at two thirds of a mile west-north-west of Pensilva Church.

<sup>1</sup> Webb and Geach, 'History of Mining in the Caradon and Liskeard District,' 1863, p. 14.

<sup>2</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, 1871, Table XXVI.

<sup>3</sup> 'History of Mining in the Caradon and Liskeard District,' 1863, pp. 24-26.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.E.

The country-rock consists of decomposed andalusite-schist forming part of the metamorphic aureole surrounding the granite, with some granite at depth.

There are eight lodes in this sett all underlying north, and a Caunter with a southerly underlie, which courses E. 30° N. and is about 4 feet wide.<sup>1</sup>

There is a good gossan in the Main Lode. Black and yellow copper-ores occurred in a gangue consisting of quartz with some prian and capel.

The total output, between 1864 and 1884, amounted to 37,530 tons of copper-ore containing 2,590 tons of metallic copper.

#### WHEAL PHŒNIX, LINKINHORNE.

(*Idle*.)

The shafts are situated about two-thirds of a mile north of Cheesewring Railway.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 N.W.

The country-rock consists of granite and metamorphosed killas. The hanging-wall of the Main Lode down to a depth of 35 fthms. consists of slate, while the north or foot-wall is granite.

The mine was started in 1836 as the Cornwall Great United, but after 1876 was taken over by another company and described as the Phœnix United.

The principal lode is the Main Lode, which courses from 8° to 15° north of east and underlies south at about 20°. It varies in width from 1 to 12 ft.<sup>2</sup> and is frequently brecciated and often vughy. There are several minor lodes to the south, within a distance of 200 fthms., and known as the New Lode, the South Lode and the Snuff-box Lode, which all underlie more steeply to the south than the Main Lode. There is also a cross-course which courses north and south, underlies west and throws down the beds to the east for a distance of 100 ft. The country-rock near the lode is much silicified and according to Collins<sup>3</sup> contains particles of tin-, copper-, and other ores. Collins further states 'the lode itself where worked was largely composed of hydrated oxide of iron (gozzan) near the surface, and some tin. Lower down there was much quartz with chlorite, many varieties of copper ore, and a little tin, but little or none of the fluor spar which was so abundantly found in several of the neighbouring mines.' Henwood<sup>4</sup> says 'After the mine had been

<sup>1</sup> Webb and Geach, 'History of Mining in the Caradon and Liskeard District,' 1863, pp 48-50.

<sup>2</sup> W. J. Henwood, *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, 1871, Table XXV.

<sup>3</sup> 'The West of England Mining Region,' 1912, p. 250.

<sup>4</sup> Henwood quoting West. *Trans. Roy. Geol. Soc. Cornwall*, vol. viii, Table XXV.

wrought for some time the lode was found to rest conformably upon another, from 6 ft. to 30 ft. wide, consisting mostly of quartz and chlorite, often largely charged with tin-ore. These veins occasionally united, fragments of each being found in the other.' Webb and Geach<sup>1</sup> state that at the Clanacombe Mine gossan extended to a depth of 200 fthms. and was intermixed with grey ore. 'In depth the matrix is generally composed of blue capel, carrying a leader of quartz and iron, in which the ore makes; and a quantity of blue and green carbonate is also found.' Rich courses of ore occurred at the 86-fthm. and the principal bunches lay between the 120- and 161-fthm. levels; the ore held down to the 216-fthm. level.

Examination of the capels left by old miners shewed that they contained from  $\frac{1}{2}$  to  $\frac{3}{4}$  per cent. of low-grade tin-ore. The mine stopped in 1898, but was reopened without success in 1907.

The total output of copper-ores between 1824 and 1878 amounted to 80,520 tons and of metallic copper 5,420 tons. At Phoenix United between 1876 and 1898 the output of copper-ore was 2,166 tons and 217 tons of copper.

### TREVEDDOE MINE, WARLEGGON.

(Active.)

Shafts at Treveddoe beside the Warleggon river, and about half a mile north-west of Warleggon Church.

*Maps*:—One-inch New Series Ordnance and Geological, 336: Six-inch Cornwall, 27 S.W.

The country-rock consists of granite on the north and metamorphosed calcareous slate (Middle Devonian) on the south of the mine.

The mine sett includes the Old Wheal Whisper openworks and the Cabilla Mine. The Main Lode courses nearly due east and west, is vertical to the 32-fthm. level, has a southerly underlie down to the 48-fthm. and changes to a north underlie down to the 60-fthm. It varies from 3 to 6 feet in width, but in the granite it was of the nature of a 'stockwerks' and consisted of numerous stringers. In the upper parts of the mine down to 15 fthms. below adit (7 fthms.) the lode was mainly tin bearing, but below that level copper-ores came in and the production of tin fell off. Copper-ores were most abundant down to 32 fthms. but are as rich in quality down to the 90-fthm. level. They comprise bornite and chalcopryite with some peacock ore. Green carbonate and some metallic copper occurred above the 15-fthm. level. The gangue consists chiefly of peach.

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<sup>1</sup> 'History of Mining in the Caradon and Liskeard District,' 1863, p. 30.



The following assays were supplied by the Company; they were made by Johnson & Son, Paul Street, Finsbury, and relate to concentrates delivered between May 1917 and November 1918:—

(1) 11.35 % Metal Tin.	(3) 15 % Metal Tin.
15.03 % „ Copper.	15 % „ Copper.
(2) 13.00 % „ Tin.	(4) 22 % „ Tin.
16.00 % „ Copper.	14 % „ Copper.

The plant is operated by five water-wheels. Most of the copper-ore is separated from the tin-ore on Frue vanners.

The following figures, supplied by the Company, give the output of copper-ore during recent years:—

1902	186 tons.	1907	—	1912	Sold as mixed
1903	1,031 „	1908	110 tons.		concentrate.
1904	564 „	1909	146 „	1913	} No figures available.
1905	—	1910	65 „	1916	
1906	17 tons.	1911	34 „	1917	
					27 tons.

The output of copper-ore in 1823, 1824, 1862, 1904 and 1906 was 65 tons, yielding 6 tons of metallic copper.

### CROWS NEST, ST. CLEER.

(Active.)

The precipitation tanks lie a few hundred yards north of Crows Nest and  $1\frac{1}{2}$  miles north-north-east of St. Cleer Church.

*Maps*:—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 28 S.W.

The drainage waters from West Caradon, South Caradon and Gonamena Mines are directed through launders in which many horse-shoes are placed. The shoes are all arranged with their points facing up-stream. There are several hundred yards of launders. The precipitated copper is brushed off with steel brushes, dressed in kieves and packed in barrels for the smelter.

The output<sup>1</sup> in 1915 was 1 ton 9 cwt., in 1916 11 cwts., and in 1917 27 tons.

### V. EAST CORNWALL AND DEVON DISTRICT.

This mining district consists of an area of about 18 square miles, composed of metamorphic rocks and granite masses, lying between Kelly Bray and Tavistock. In it are situated the famous Devon Great Consols Mines, the Hingston Down Mines, and the Holmbush and Gunnislake Clitters and Bedford United Mines. There is a second group lying on the borders of Dartmoor north-east of Tavistock and including Wheal Friendship and some smaller mines. There are also many mines of lesser importance with outputs amounting to less than 20,000 tons of copper-ore of which no details are known.

<sup>1</sup> 'The Cornish Chamber of Mines Year Book,' by H. E. Fern, 1918, p. 62.

## GUNNISLAKE CLITTERS, CALSTOCK.

*(Formerly worked by the Duchy of Cornwall.)*

Shafts in Clitters Wood two-thirds of a mile west-north-west of Gunnislake. A tramway leads to a siding on the East Cornwall Railway five-sixths of a mile from Gunnislake station.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Devon, 105 S.W. ; Cornwall, 29 N.E.

The country-rock is granite. The ores are copper glance, the black and red oxides and smaller amounts of arseniates, phosphates and uranates of copper.

There are four principal lodes in the sett which course in a general direction of E.  $12^{\circ}$  N., and parallel with the lodes in Hingston Down Mine. They may be continuous with those at the Hawkmoor and the Bedford United Mines. All underlie to the south.

No. 2, the principal lode, has been worked on to a depth of 275 fthms. below adit, and from it large amounts of copper-ore have been raised ; but the quantity was observed to decrease in depth. It is said that at the Clitters Mine above adit-level the lode is worked out, but below, though narrow, it is still rich.

The total output of copper-ores from 1822 to 1827, from 1860 to 1889, and from 1902 to 1904 amounted to 33,310 tons, yielding 2,760 tons of metallic copper.

## HINGSTON DOWN AND CONSOLS, CALSTOCK.

*(Active.)*

The shafts are situated on Hingston Down,  $1\frac{1}{4}$  miles west of Gunnislake station.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 29 N.E., and Devon, 105 S.W.

The country-rock consists of highly tourmalinised killas overlying granite on the west, and of granite on the east of the sett.

There are several lodes, the principal being the Main Lode and the South or Hitchin's Lode. They have a general northerly underlie and strike about E.  $12^{\circ}$  N. The Main Lode is of great width in parts and consists of numerous strings of mineralized rock carrying sulphide ores and there is also some fluorspar. It underlies N. at  $60^{\circ}$ . In width it varies considerably and appears to be richer in tin and wolfram at depth than near the surface, but less rich in ores of copper and in mispickel. Hitchin's Lode was proved to be 20 feet wide at 65-fthms. and there carried 6 per cent. of mixed tin-, wolfram-, and arsenic-ores.

Hingston Mine reached a depth of 172-fthms. and there is much untouched ground in the lower part.

This mine forms one of the group ' Kit Hill, Hingston Down, and Gunnislake Clitters ' ; until recently worked by the Duchy of Cornwall. The stamps and dressing-plant were situated at Gunnislake Clitters Mine ; the ore from Kit Hill and Hingston Down was conveyed to them by aerial ropeway.

The total output between 1850 and 1880 and in 1882 amounted to 64,440 tons of copper-ore and 3,092 tons of metallic copper.

### HAWKMOOR MINE, CALSTOCK.

(Active.)

Shafts situated near the river Tamar, a quarter of a mile north of Gunnislake Bridge.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 30 N.W.

The country-rock consists of andalusite-mica-schist overlying greisened granite, and on the west of the sett faulted by a cross-course against granite at a few fathoms below the surface.

There are five lodes called respectively the North Lode, the Tavistock or the Main Lode, and the South Lodes, Nos. 1, 2 and 3. They may be the same as those at Bedford United Mines, the Main Lode and the South Lode No. 1 of Hawkmoor merging into the Tavistock Lode of Bedford United, while the South Lodes Nos. 1 and 2 unite to form the Marquis Lode. The South Lodes were formerly known as the Bedford, Bedford No. 1, and the Deal's or Devil's Kitchen Lodes. They course in a general direction of E. 10° N., but tend to diverge towards the south-west of the property. The North Lode and the Main Lode underlie N. at 10°, and the others to the south.

The Main Lode and the South Lodes contain copper-ores.

The output of copper-ore amounted to 4 tons 11 cwt. in 1917. Between 1852 and 1866 the output was 3,559 tons of copper-ore and 211 tons of metallic copper.

### HOLMBUSH AND HOLMBUSH CONSOLS, STOKE CLIMSLAND.

(Active in part.)

The shafts are situated about 700 yards north of Kelly Bray.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Cornwall, 29 N.W.

The country-rock is slate of Upper Devonian age metamorphosed by the granite. At Wall's Shaft between the 80- and the 100-fthm. levels, and at Hitchin's Shaft, between the 110- and 146-fthm. levels there is an intrusion of greenstone. The lodes, as usual, are narrow and poor in the greenstone, but become ore-bearing below it.



The following account is abstracted from Collins.<sup>1</sup> There are five known east and west lodes in the Holmbush group, as well as the great north and south silver-lead lode. The Main Lode is the most northerly of them; it courses a few degrees N. of E., underlies N. at 20° from the vertical, and varies from a few inches to many feet in width. It consists mainly of quartz, mispickel and iron pyrites and carries chalcopyrite and other ores of copper with occasionally much fluorspar. The lode has been worked for a considerable length and to a depth of 175 fthms. below adit.

The Flop Jack, also a rich lode, courses in a general east-and-west direction and underlies north at 1 in 2. It contains tin-, copper- and arsenic-ores, and has been worked down to the 145-fthm. level. The lode, just west of the Main Lode, is displaced by the Great Cross-course.

In 1888 this mine, with its neighbours Kelly Bray, South Kelly Bray, and Redmoor, was worked by the Callington United Mines, Limited.

The output between 1822 and 1868, and from 1880 to 1886, amounted to 42,900 tons of copper-ore with 3,125 tons of metallic copper.

#### DEVON GREAT CONSOLS, TAVISTOCK.

(Active in part.)

Shafts at Wheal Anna Maria and at Wheal Fanny, about 1½ miles north of Gunnislake.

Maps:—One-inch New Series Ordnance and Geological, 337 : Six-inch Devon, 105 S.W.

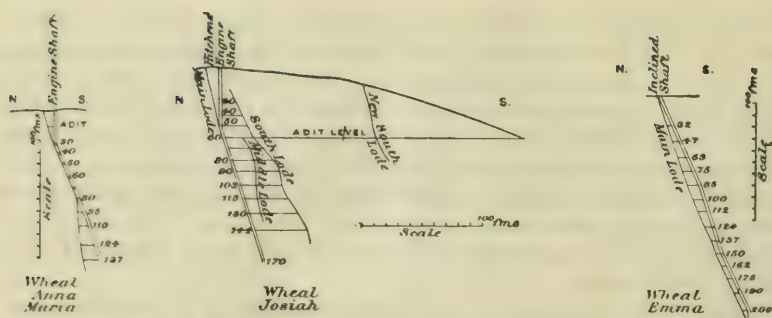
A long account of these mines is given by Collins.<sup>2</sup> The sett includes, among other, smaller workings, Wheal Maria, Wheal Fanny, Wheal Anna Maria, Wheal Josiah and Wheal Emma. The lodes have been worked on continuously for a distance of over two miles in Devon and possibly to a greater distance through New Great Consols on the Cornish side of the Tamar. The workings generally did not exceed 220 fthms. below adit level and were everywhere rich in copper-ores (Fig. 13). These lodes were discovered in the early part of the 19th century, their 'backs' having been observed as cindery masses of gossan. During the working of the mines this gossan material was occasionally followed to great depths, but in general it extended for 30 to 40 fthms. and then passed into compact masses of mixed sulphide ores with mispickel and much quartz and fluorspar.

The country-rock consists of Upper Devonian slate which shews spots due to metamorphism and is called by the miner 'the lousy killas.'

There are four principal lodes, but only the Main Lode and the New South Lode are now worked. The Main Lode in the western

<sup>1</sup> 'The West of England Mining Region,' 1912, pp. 257-261.

<sup>2</sup> 'The West of England Mining Region,' 1912, pp. 262-265. — *set*

FIG. 13. *Devon Great Consols. Cross-sections of lodes.*

part of the sett courses almost due east and west, but eastwards swerves to E.  $15^{\circ}$  N. It underlies generally south at 1 in 3, and ranges up to 30 ft. or rarely 40 ft. in width. Much of the material is breccia cemented by chalybite and iron-pyrites. The New South Lode has a similar bearing and underlie to the Main Lode.

The South Lode branches off from the Main Lode in Wheal Anna Maria and rejoins it in Wheal Josiah. It was extremely rich between the 20-fthm. and the 120-fthm. levels; and also where it joins the Main Lode. There it attains a width of 40 ft., and consists of mispickel and chalcopryite in a brecciated veinstone.

The Main Lode is worked at Wheal Fanny at the Eastern Shaft. It consists only of mispickel and copper-ores in a gangue of quartz with patches of peach and fluorspar, and is about 6 ft. thick. At Wheal Anna Maria (Fig. 13) both the Main Lode and the New South Lode are being worked.

There are extensive dumps which were recently estimated to contain three-quarters of a million tons of material which assayed on an average one half per cent. of metallic copper.

In the old mines there are 40 miles of levels. The drainage waters from above adit-level are conveyed through launders in which scrap-iron and steel shavings are placed. The copper in the drainage water is in the form of sulphate; on reaching the launders iron replaces copper, precipitating it as a soot on the shavings and itself forms sulphate of iron. The shavings are washed in sieves and the copper collected in tubs where it is dried and packed, but not more than 85 per cent. of water is removed as dry copper is not required by the manufacturer. This precipitated copper contains, according to recent information, up to 40 per cent. of iron. The mine waters by analyses shew a maximum of 30 grains of copper per gallon, but the proportion varies according to season and rainfall. The recovery of copper averages about 45 tons per annum.

The output of copper-ores between 1845 and 1903 amounted to 742,400 tons yielding 48,285 tons of metallic copper. Collins<sup>1</sup> states that the 'total production from the commencement in 1844 to the winding up in 1903 realised over four millions sterling.

<sup>1</sup> 'The West of England Mining Region,' 1912, p. 265.

## BEDFORD UNITED MINES, TAVISTOCK.

(Active.)

Shafts situated on the Devon slope of the Tamar Valley, half a mile north-east of New Bridge, Gunnislake.

*Maps*:—One-inch New Series Ordnance and Geological, 337 : Six-inch Devon, 105 S.W.

The country-rock consists of slightly metamorphosed killas of Upper Devonian age.

There are three lodes coursing about E.  $15^{\circ}$  N. and underlying at  $70^{\circ}$  to the south. The most northerly, the Tavistock Lode, has been stoped to a width varying from 2 to 7 ft. The Marquis Lode, averaging 6 ft. in width, has been worked to the 150-fthm. level and is at present working down to adit-level (50 fthms.). Copper pyrites and mispickel affect the centre of the lode, while tin- and wolfram- ores lie next to the walls. The gangue consists of quartz with some fluorspar and capels of schorl.

The No. 1 Lode has been worked to a depth of 200 ft. It contains ores of copper, arsenic, tin and wolfram in a quartz gangue with some fluorspar. The values of copper and arsenic increase with depth, and their average at present is 1 per cent. of copper and 3 per cent. of arsenic. Old workings on the back of the lode above the deep adit extend for a distance of 200 fthms.

The mills and dressing plant are modern, and are worked by water-power operating a Pelton turbine wheel.

The output of copper-ores between 1844 and 1889 amounted to 65,950 tons yielding 4,476 tons of metallic copper.

## WHEAL FRIENDSHIP, MARYTAVY.

(Active.)

Shafts about half a mile north-north-west of Marytavy Church.

*Maps*:—One-inch New Series Ordnance and Geological, 338 ; Six-inch Devon, 98 S.W.

The country-rock consists of Culm Measure shales and intrusive greenstone near the limits of metamorphism effected by the granite.

This mine was an important producer of copper as far back as 1796. Adit-level is at 20 fthms. There are two principal and several small lodes and a cross-course.

The following account is derived from Collins.<sup>1</sup>

The Main Lode courses nearly E. and W. (the east part a little south of west, and the west part slightly north of west); underlies north at angles varying from  $40^{\circ}$  to  $70^{\circ}$ , but averaging about  $60^{\circ}$ ; and varies in width from 2 ft. to 30 ft., with an average

<sup>1</sup> 'The West of England Mining Region,' 1912, p. 268.



of about 6 ft. It has been worked on to a depth of 265 fthms., and was exceptionally wide between the 40-fthm. and the 50 fthm.; the 70-fthm. and the 100-fthm.; and at the 200-fthm. levels. At surface and also at the 100-fthm. level it consisted of several distinct branches often connected together by veinlets of quartz. The lode-contents near the surface consisted largely of earthy brown iron-ore (gossan) and quartz, below this there was much chalcopryite, iron-pyrites and arsenical pyrites, with some chlorite, and at the 112-fthm. level cassiterite made its appearance. Sprague's Lode follows a similar course and outcrops to the south of the Main Lode but underlies to the north at a steeper angle. It has been worked on to the 240-fthm. level. Other lodes were also worked, such as James's, Gifford's and Pearce's.

The total recorded output of copper-ore between 1846 and 1883 and in 1909 was 42,900 tons, yielding 4,000 tons of metallic copper.

#### WHEAL CREBOR (THE OLD CROWDALE AND WEST CREBOR), TAVISTOCK.

(Idle.)

Shafts near the river Lumburn, about 2 miles south-west of Tavistock and  $2\frac{1}{4}$  miles by road from Tavistock station.

*Maps* :—One-inch New Series Ordnance and Geological, 337 : Six-inch Devon, 105 S.E.

The country-rock consists of Upper Devonian slate.

There are two lodes, the North Lode and the South Lode, which course in a general east-north-east direction and underlie north. The North Lode at Wheal Crebor was worked on down to the 120-fthm. level, and there were four shafts. At West Crebor the workings apparently did not go lower than 66 fthms. and there were three shafts. The lodes contained copper- and arsenic-ores.

The output at Wheal Crebor between 1872 and 1901 was 34,900 tons of copper-ore.

#### SUNDRY OCCURRENCES OF COPPER-ORES WHICH ARE NOT TRUE LODES.

##### FORD ARSENIC AND COPPER MINES, STICKLEPATH BY OKEHAMPTON.

(Idle.)

Shafts and adit at Ford,  $\frac{1}{4}$  mile south of Sticklepath, and 4 miles by road from Okehampton station (G.W.R.).

*Maps* :—One-inch New Series Ordnance, 324; Old Series Geological, 25; Six-inch Devon, 77 N.W.

The country-rock consists of metamorphosed shales of Culm Measure age. Veins from the granite traverse the sediments near a flucan bounding the lode. The lode courses E. and W.,

underlies to the north, and is 16 ft. wide. The shaft has been sunk to a depth of 62 ft. and meets the adit. A cross-course 40 ft. wide is of the nature of a flucan and carries finely disseminated arsenical pyrites. Bounding the "lode" and forming both the hanging- and the foot-wall is a massive rock consisting of aggregates of axinite, actinolite and quartz through which are developed isolated crystalline masses of copper and arsenical pyrites.

At the neighbouring Belstone Mine (now flooded) the ores lie in a massive garnet (allochroite) rock, which in places consists of hornfels embedding many idiomorphic crystals of pale-green garnet. The main shaft is down 73 fthms., while the incline shaft on the Great Lode reaches a vertical depth of 54 fthms. Smyth<sup>1</sup> describes this lode as a 'powerful bedded mass of garnet rock' with some parts 'intermingled with schistose bands of matted pale-green actinolite.' 'This thick band . . . . is specked throughout, but very irregularly, with pyrites, mispickel, and black and grey copper ores, whilst occasionally these metallic sulphides and oxides are accumulated in strings running sometimes with, but often quite against, the direction of the stratification.'

From 1867 to 1891, 2,934 tons of copper-ore were sold.<sup>2</sup>

## VI. THE SOUTH MOLTON DISTRICT.

There are several old copper mines marked on the Old Series Geological Map 27 (published in 1835, revised in 1839) between North Heasley and South Rodworthy, 2 miles north of North Molton. On the six-inch map Devon, 15 N.W., the following are marked in the neighbourhood of Heasley Mill:—Bampfylde Copper Mine, New Florence Mine, Crowbar Iron Mine, Stowford Iron Mine. One of these mines was described by De la Beche as 'one of the oldest copper mines in Devon,' which was in work in 1729 but abandoned before 1778.<sup>3</sup>

Of these mines J. H. Collins states 'the mines here were rather extensively worked a century or more ago, and again with some intermission from 1856 to 1882.' 'In this belt [of brown and claret-coloured Lower Devonian slates] there are many veinlets carrying copper, the general trend of which is parallel with the stratification . . . . the principal group of veinlets, which has been called the lode, consists of a series of elongated lenses forming a kind of bedded vein. Both this and many of the subordinate veinlets are filled with quartz associated with specular iron and limonite and carrying considerable quantities of copper, principally in the form of chalcopyrite below water-level and of malachite above, although chalcocite,

<sup>1</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. ix, 1878, pp. 41, 42.

<sup>2</sup> J. H. Collins, 'The West of England Mining Region,' 1912, p. 414.

<sup>3</sup> H. T. De la Beche, 'Rept. on the Geology of Cornwall, Devon and West Somerset,' 1839, p. 609.

bornite and azurite are also occasionally found.<sup>1</sup> Collins considered that there was no true lode, but a concentration of ore material derived from adjacent beds in zones of minor fracturing.

Recent information given by the manager of the Company is to the effect that in the Bampfylde Mine the principal lode, called the Maiden or the Peacock Lode, courses east and west and underlies south. The shaft was sunk to a depth of 147 fthms. where grey copper-ore, assaying 17 per cent. metallic copper, was found in a gangue of spar with micaceous iron-ore. The lode averages about 6 ins. in width. Adit-level is at 35 fthms. from the surface. There is another lode at a distance of 120 ft. north of the Peacock Lode, also coursing east and west and underlying south. The mine is flooded. It was never worked east but only west of the valley, and the lode is said to become impoverished eastwards. It is stoped out down to the 112-fthm. level.

In the neighbouring Britannia Mine a lode coursing east and west and underlying south contains copper-ore. S. R. Pattison<sup>2</sup> describes the lode in this mine as a quartzose metalliferous gossan, and remarks that gold in grains was found, as described by Lysons<sup>3</sup> and by De la Beche.<sup>4</sup>

Of the copper mines in Somerset De la Beche<sup>5</sup> recorded the following particulars. 'The copper adventures of West Somerset appear never to have become of much value. The chief workings seem to have been at Doddington, on the N.E. of the Quantocks. The ores raised here were principally carbonates; and Mr. Leonard Horner has pointed out that green and blue carbonates of copper were first worked in the red sandstone conglomerate down upon the lode in the grauwacke beneath.'<sup>5</sup>

'Shafts have been sunk at other places, such as Grabbist Hill, near Minehead, but without any profitable return. Copper is not raised in Somerset at present.'<sup>6</sup>

<sup>1</sup> 'The West of England Mining Region,' 1912, pp. 30, 31.

<sup>2</sup> *Trans. Roy. Geol. Soc. Cornwall*, vol. vii, 1865, pp. 223-227.

<sup>3</sup> *Devonshire*, ii, p. 267.

<sup>4</sup> 'Rept. on Cornwall, Devon and West Somerset,' 1839, p. 614.

<sup>5</sup> *Trans. Geol. Soc.*, London, vol. iii, pp. 352 and 363

<sup>6</sup> *Op. cit.*, p. 609.



## APPENDIX.

## PLANS OF ABANDONED MINES.

Plans of some of the abandoned mines referred to in this volume are preserved at the Department of Mines. The following list is taken from the Official Blue Book: 'List of Plans of Abandoned Mines deposited in the Home Office,' 1920. Plans with the letter R prefixed to the number, and also those of all mines that had been abandoned for more than ten years on 31st December 1919, are open to inspection.

The last column in the following list gives the pages of the present volume on which the mine is mentioned.

Register Number.	Name of Mine.	Post Town or Parish.	Date when received.	Page in Text.
R 287	- Alfred - - -	Phillack -	—	17
R 222	- Basset, East - -	Illogan -	1872	27
652	- Basset, East - -	Redruth -	—	27
—	Basset, East. ( <i>See also Buller.</i> )			27
2451	- Bassett, North -	—	14.5.1890	9
2564	- Basset and Buller Consols and Copper Hill.	Wendron and Redruth.	8.6.1891	28
1592	- Basset and Gryll -	Wendron -	3.4.1884	29
R 246	- Basset and Grylls -	Wendron -	1865, 1875	29
R 46	}	Botallack - - St. Just-in-Penwith.	24.6.1895	15
R 107				
3307				
6174	- Botallack - - -	St. Just-in-Penwith.	2.10.1914	15
1835	- Bostallack, East -	St. Just -	20.2.1886	15
R 47	- Briggan, Great -	Redruth -	1865	29
R 151	- Bucketts - - -	—	—	39
R 230	- Buller - - - -	Redruth -	1868	28
R 222	- Buller and Basset United.	Wendron -	—	28
652	- Buller and East Basset.	Redruth -	27.2.1877	29
R 38	}	Buller, North - Redruth -	—	29
R 209				
R 124				
R 66	- Camborne Vean -	Camborne -	—	39
R 34	- Caradon and Phoenix United.	Linkinhorne	—	52
R 22	- Caradon Consuls -	St. Cleer -	—	
R 59	- Caradon, East -	Linkinhorne	—	50
1919	- Caradon, East -	Linkinhorne	15.7.1886	50
2176	- Caradon, East -	Linkinhorne, Liskeard.	30.6.1888	50
736	- Caradon, South -	St. Cleer -	16.3.1878	48
1859	- Caradon, South -	St. Cleer -	10.4.1886	48
R 91	- Caradon, South -	St. Cleer -	1878, 1879	48
2131	- Caradon, New South	St. Cleer -	3.9.1887	48
R 164	- Caradon, West -	St. Cleer -	—	48

Register Number.	Name of Mine.	Post Town or Parish.	Date when received.	Page in Text.
2807	- Caradon, West -	St. Cleer -	1.12.1892	48
6521	- Carn Brea, Cook's - Kitchen and Macdonalds.	Illogan - P.T. Carn Brea.	16.6.1916	24
R 57	} Carn Brea, East -	Redruth -	24.6.1890	39
2451				
947	- Carn Brea, South -	Illogan -	14.2.1879	40
R 45	- Carn Camborne -	Camborne -	—	39
R 56	} Carnyorth -	St. Just -	—	15
R 107				
R 314				
R 24				
R 297	- Carvannel -	Gwennap -	—	39
R 99	- Chacewater or Busy	Chacewater -	—	37
R 89	- Charlotte, Great -	St. Agnes -	—	19
R 89	- Clifford -	Gwennap -	1854	34
R 140	- Clifford United West, Ting Tang and Moyle.	Gwennap -	—	34
R 79	- Clowance Wood -	Crowan -	1863	40
R 89	- Clyjah and Wentworth.	Redruth -	1859	40
R 36	- Comford -	Gwennap -	1882	32
R 219	- Condurrow -	Camborne -	1864	27
6438	- Condurrow -	Camborne -	21.9.1915	27
R 80	- Condurrow South -	Camborne -	—	27
R 80	- Condurrow, West -	Camborne -	—	—
2252	- Condurrow, West -	Camborne -	July, 1888	—
R 103	- Consolidated Mines	Gwennap -	(Dates of plans 1821, 1832, 1833.)	34
R 6	- Cook's Kitchen - Cook's Kitchen ( <i>see also</i> Carn Brea).	Camborne -	—	6
3994	- Cook's Kitchen, New	Camborne -	2.3.1900	25
R 6	} Cook's Kitchen, New		—	25
R 19				
R 64	- Creegbraws -	Kenwyn -	—	30
R 64	- Creegbraws and Penkevil United.	Kenwyn -	—	30
683	- Crenver and Abraham.	Crowan -	13.1.1877	40
R 97	- Crenver and Abraham.	Crowan -	1876	40
R 67	- Crenver, South -	Crowan -	—	40
1325	- Crinnis & Carlyon -	St. Austell -	6.2.1882	—
R 113	- Crinnis & Carlyon Consolidated, Gt.	Par -	—	—
R 112	- Crinnis, East -	St. Blazey -	1822	44
R 27	- Crinnis, East, and South Par.	St. Blazey -	—	44
R 66	- Crinnis, West, and Regent United.	St. Austell -	—	—
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R 208	Darlington, West -	Marazion -	1855	—
R 258	Downs, East -	Kea -	—	—
R 40	} Downs, North -	Redruth -	—	29
R 49				
R 127	Downs, Little North -	Redruth -	—	29
R 53	Ellen, East - - -	St. Agnes -	—	40
R 288	Ellen, South -	St. Agnes -	—	40
R 307	Fanny - - -	Camborne -	—	—
R 98	Fowey Consols -	St. Blazey -	—	42
82	Fowey Consols, South.	Tywardreath	15.4.1874	42
R 98	Fowey Consols, West	Tywardreath	—	42
R 66	Frances - - -	Camborne -	—	—
R 122	Frances, New -	Crowan -	—	—
R 48	} Frances, South -	Illogan -	—	28
R 110				
R 2	Frances, West -	Illogan, Camborne.	1877	27
3821	Frances, West -	Illogan, Camborne.	27.8.1898	27
R 110	Frances, West -	Illogan -	—	27
R 129	} Friendship - - -	St. Hilary -	—	17
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R 159	Glasgow Caradon -	Liskeard -	1861	51
R 208	Gonamena - - -	St. Cleer -	—	50
R 145	Good Fortune and Little Speed.	Perranza-buloe.	—	18
R 245	Gorland - - -	Gwennap -	(Dates of plans, 1831, 1832,)	30
5819	Gorland - - -	Gwennap -	13.5.1912	30
R 21	Gorland, West -	Gwennap -	1873	30
R 304	Grambler - - -	Redruth -	—	40
R 40	Grambler & St. Aubyn.	Gwennap -	—	40
R 89	Grambler, North -	Gwennap -	—	40
R 78	Grenville, East -	Camborne -	—	27
565	Grenville, East -	Camborne -	19.7.1876	27
2846	Grenville, West (formerly Trevoole).	Crowan, Camborne.	24.1.1893	27
R 63	} Gunnislake Clitters	Gunnislake -	23.3.1891	55
2538				
R 246	Gunnislake, East, and Bedford Consols.	Calstock -	—	—
R 212	Gunnislake, Old -	Calstock -	1878	—
R 30	Guskus - - -	St. Hilary -	—	17
R 152	Hallamanning and Croft Gothermal.	St. Hilary -	1853	17
R 310	Hawkmoor -	Gunnislake -	1863	56
R 310	Hawkmoor, West -	Calstock -	1861, 1863	—
R 302	Hearle - - -	St. Just -	—	—
1837	Hingston Down Consols.	Calstock -	23.2.1886	55



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86 -	Holmbush & Kelly Bray.	Stoke Climsland.	27.4.1874	57
1578 -	Jewell - - -	St. Hilary -	7.4.1884	30
R 18 -	Jewell - - -	St. Hilary -	1846	30
R 35 -	Lanescot - - -	Tywardreath	(Date of plans 1830.)	42
R 14 -	Leisure, East -	Perranzabuloe	1850	18
6709 -	Leisure, New -	Perranporth	20.12.1917	18
R 195 -	Leisure, North Mine	Perranzabuloe	—	18
R 31 -	Marazion - - -	Marazion -	—	17
R 165 -	Margery - - -	St. Ives -	1865	17
R 311 -	Maria - - -	Crowan -	1844	40
1640 -	Marke Valley -	Linkinhorne	21.10.1884	51
2534 -	Marke Valley, or Jenkyn.	„	2.3.1891	51
R 91 -	Marke Valley -	„	—	51
R 21 -	Mary - - -	Redruth -	1854	40
R 54 and 2374. -	Mellaneer - - -	St. Erth -	23.9.1889	16
R 183 -	Music - - -	St. Agnes -	—	40
R 99 -	Nangiles - - -	Kea -	—	40
R 199 -	Neptune - - -	Perranuthnoe	—	17
4482 -	Owles - - -	St. Just -	12.10.1903	15
R 211 -	Owles - - -	St. Just -	—	15
R 100 -	Par Consols - -	St. Blazey -	—	44
R 83 -	Par Consols, West -	St. Blazey -	1860	44
R 72 -	Peevor or Pever -	Redruth -	1882	29
R 59 -	Peevor, West -	Redruth -	1882	29
R 149 -	Pembroke - - -	St. Austell -	(Dates of plans, 1833, 1837.)	45
R 148 -	Pembroke & East Crinnis.	St. Austell	(Dates of plans, 1823, 1828, 1834.)	44
607 -	Pembroke, New -	St. Blazey -	17.11.1876	45
R 86 -	Perran, George -	Perranzabuloe	—	19
R 23 -	Perran, Great -	—	—	18
R 160 -	Perran St. George United.	Perranzabuloe	1850	18
R 68 -	Perran United -	Perranzabuloe	—	18
6571 -	Phoenix - - -	Linkinhorne	16.6.1916	52
53 -	Poldice, part of -	St. Day -	25.11.1873	30
R 16 -	Poldice, West -	Gwennap -	1876	30
R 150 -	Prosper - - -	St. Hilary -	1845	17
R 64 -	Prosper, Great, Good Providence and Beam Mine Lodes.	St. Hilary -	—	17
R 198 -	Prosper United -	St. Hilary -	1863, 1868	17
1020 -	Providence - - -	Lelant -	Aug. 1878	6
R 250 -	Providence - - -	Lelant -	1855, 1875	6
R 309 -	Prudence - - -	St. Agnes -	—	19

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R 38	Relistian - - -	Gwinear -	1840	17
4151	Retallack - - -	Perranzabuloe	24.10.1901	17
1094	Retallack, North -	„	25.11.1879	17
R 75	Rose - - -	Scorrier -	—	—
R 60	Rosewarne Consols	Gwinear -	—	17
693	Rosewarne, New -	Gwinear -	18.4.1877	17
R 212	Rosewarne, New -	Gwinear -	1875	17
574	Rosewarne, North -	Gwinear -	31.3.1875	17
R 217	Rosewarne United,	Gwinear -	1855, 1859	17
R 30	Rosewarne United,	Gwinear -	—	17
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R 217	Rosewarne & Her-	Gwinear -	1851, 1855,	17
	land United.		1859.	
R 258	Roskear - - -	Tuckingmill-	—	22
R 42	Roskear, North -	Camborne -	—	22
1532	Roskear, South -	Camborne -	25.10.1883.	22
R 209	Roskear, South -	Camborne -	1882	22
R 156	Roskear, West -	Camborne -	1879	—
575	Seton - - -	Camborne -	25.5.1876	22
R 191	Seton - - -	Camborne -	1850, 1876	22
R 191	Seton, East - -	Camborne -	—	22
R 31	Seton, New - -	—	—	22
R 31	Seton, South -	—	—	22
R 32	Seton, West - -	Camborne -	—	22
R 310	Speedwell - - -	St. Just -	1842	17
R 15	Squire - - -	Gwennap -	—	35
R 78	Stray Park - -	Camborne -	—	20
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R 304	Tolcarn - - -	Redruth -	—	—
R 66	Tolcarne - - -	Camborne -	—	40
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R 92	Tolcarne, South -	Camborne -	—	29
R 161	Tolgus - - -	Redruth -	—	39
R 247	Tolgus, East - -	Redruth -	1871	39
R 78	Tolgus, Great South	Redruth -	14.5.1890	39
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R 133	Tolgus, South -	Redruth -	1870	39
1596	Tolgus, West - -	Illogan -	16.5.1884	39
R 134	Tolgus, West - -	Illogan -	1880	39
R 86	Tolvadden - - -	Marazion -	—	17
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R 315 -	Trethellan - -	Gwennap -	—	32
R 7 -	Treviskey - -	Gwennap -	—	32
R 312 -	Trevoole - -	Crowan -	1859	40
5690 -	Tywarnhaile -	Scorrier -	12.10.1911	—
R 113 -	Tywarnhaile -	St. Agnes -	—	19
R 4 -	Tywarnhaile, East	St. Agnes -	1851	—
R 135 -	Tywarnhaile United Mines (United Hills, Charles & South Towan)	St. Agnes -	1851, 1865	40
R 1 -	Tywarnhaile Banns, and Tallack	St. Agnes -	—	—
R 113 -	United Hills -	Tywarnhayle	—	40
R 101 - } 102 - } 103 - } 104 - }	United Mines, Clifford and Andrew (Clifford Amalgamated).	Gwennap -	1817, 1868, 1870.	34
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175 -	Vor, Great - -	Helston -	19.1.1875	40
R 137 -	Vor, Great, and Sithney Metal.	Helston -	1858, 1873, 1877.	40
R 393 -	Vor, North - -	Helston -	—	—
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R 86 -	Bamfylde, New -	Bamfylde -	—	62
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R 153 -	Bedford Consols & Gawton.	Tavistock -	1881	59
190 -	Bedford, South -	Tavistock -	21.1.1875	59
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4733	- Drakewalls	- Gunnislake	13.12.1905	—
3238	- Florence, New	- North Molton	8.1.1895	61
4473	- Friendship	- Mary Tavy	(?) .5.1904	59
R 303	- Friendship, West	- Mary Tavy	—	59
2861	- Mid. Devon (formerly Belstone).	- Belstone	21.2.1893	61

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63 N.W.	Tuckingmill and Pool.
63 N.E.	Redruth and St. Day.
63 S.W.	Camborne and Troon.
63 S.E.	Lanner.
67 S.W.	Boscawell.
69 N.W.	Hayle.
69 N.E.	Rosewarne.
69 S.W.	Trannack.
69 S.E.	Townshend and Trenwheal.
73 N.W.	St. Just.
75 N.W.	Perranuthnoe and Trescowe.
75 N.E.	Boscerege and Breage.

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